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GAS ABSTRACTS

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1. GAS INDUSTRY

Controls and Regulation

Stewart, H. A. FUNCTIONS OF PETROLEUM ADMINISTRATION FOR DEFENSE *LP-Gas*, 11, 40, 89, 90 (1951) July.

PAD is to determine the quantities of petroleum and gas required for defense mobilization and for war. It must check on availability, transportation facilities, refinery capacity and storage facilities for products. It must also determine the materials required for carrying out the work, and notify the Natural Production Authority of these needs. PAD is then to distribute needed supplies equitably. Steel is a very critical material.

J. D. Parent

PAD STEPS UP DRIVE TO MAKE SURE WINTER FUEL OIL DEMAND IS MET. *Nat. Petroleum News*, 43, 20, 21 (1951) July 4.

PAD will soon set up an East Coast industry supply committee to allocate fuels, including natural gas. This committee initially will deal with a highly probable shortage of residual fuel oil. An order that would ban, except for defense use, new installations of gas-burning equipment east of the Mississippi River is in preparation.

C. H. Riesz

PROGRESS OF REGULATION. *Public Utilities Fortn.*, 48, 191 (1951) August 2.

In entertaining three mutually exclusive applications for authority to provide natural gas service in the northeastern Ohio area, the FPC awarded the certificate to the company which afforded the lowest cost of service, and the lowest rates to the distributing companies and consumers. In enunciating principles to be followed in fixing a tariff for a natural gas pipeline company, after a new supply becomes available from a newly authorized pipeline, the FPC said that the company (Panhandle Eastern Pipe Line in this case) should use so-called "rolled-in" rates, whereby the cost of the new supply is included along with the company's other costs. The rates of all customers should be based upon the total cost of the pipeline company.

A. E. Neumann

RE PHILLIPS PETROLEUM COMPANY. *Public Utilities Fort.*, 48, 147-151 (1951) July 19.

Phillips made a motion that the issues at the hearing on the company's status under the Natural Gas Act, as well as on rates and charges in connection with transportation and sale of natural gas, be limited by FPC to the determination of whether or not the company is a natural gas company within the meaning of the act. This motion has been granted in the interest of orderly procedure.

J. D. Parent

Employment

Hammett, M. ADVANTAGES OF UTILITY EMPLOYMENT. *Public Utilities Fortn.*, 48, 223-228 (1951) August 16.

The author points out the advantages of employment in public utilities. Employment is steady, pay is good and the future secure. Far sighted management has provided many employee benefits. Many utilities lost valuable young men recently due to personnel requirements of the armed forces and due to high salaries paid elsewhere. Recommendations for meeting this adverse situation are increased salary and broadened training. The young employee is to be given a sense of being an integral and valuable part of the firm.

J. D. Parent

Foreign Gas Industry

Bonetti, P. THE POSSIBLE APPLICATION OF NATURAL GAS IN PUBLIC SERVICE. (DI ALCUNE APPLICAZIONI DEL GAS NATURALE NEI PUBBLICI SERVIZI.) *Rivista dei Combustibili*, (Italian) 5, 211-235 (1951) March.

The Author, in the first part, examines the possibility of employing natural gas in gasworks as a means of increasing heat value, as a means of increasing the number of calories that can be delivered per day, as distribution gas and as raw material to be transformed in part or total substitution of coal for the production of gas with similar specifications of coal gas. In the second part the use of natural gas in thermo-electric power plants is discussed, tracing budgets for the cost of thermic kwh obtained by natural gas. This utilization of natural gas should form an integration to

the production of hydro-electric power and should not be in competition. Lastly the Author mentions the possibilities for natural gas in the chemical industry and examines the problem of the setting of this new important source of power in the Italian economy.

Author's Abstract

Brabant, M. GAS PRODUCTION IN BELGIUM: 1900-1950. *Gas J.* (British), **266**, 757-764 (1951) June 13.

Although gas was formerly supplied to Belgium by 83 separate gas plants, the bulk of the supply now comes from three large grids distributing coke oven gas produced in 20 coke plants. Some flexibility in gas production is achieved by using manufactured gas for heating the ovens, adding oil to the coal charge, and cracking oil in empty ovens. The most likely supplementary gas sources appear to be residual gas from oil refineries and methane from coal mines.

W. E. Ball

GAS TO CARACAS. VENEZUELA'S FIRST LINE TO BE OPERATING IN SEPTEMBER. *Oil Gas J.*, **50**, 71 (1951) August 9.

A 16-inch pipe line is nearing completion in Venezuela. It is to serve Caracas and certain other cities with natural gas for industrial uses. Maximum pressure is 800 psi.

J. D. Parent

Gas Sales

Peck, I. K. WHAT TO DO ABOUT SALES AFTER NATURAL GAS ARRIVES. *Gas Age*, **107**, 54, 56-57 (1951) April 26.

The general sales program required after the introduction of natural gas is discussed. The sales problem includes: public relations, utility sales, dealer coordination, home services, new appliance-house heating, industrial loads, distribution, peak shaving, and future requirements.

B. E. Hunt

Gas Supply

Hargrove, R. H. LET'S PRODUCE IT OURSELVES. *Gas*, 27, 96, 98 (1951) August.

Three means open to transmisison companies for securing additional gas are: (1) raise the purchase price, (2) extend gathering lines to pick up small or out-of-the-way reserves, and (3) get into the exploration and production phase of the business. The last step mentioned simply means full integration of the company's business. Texas Eastern has formed a production subsidiary. The peak load problem is also mentioned by the author, and storage pools are considered to be the answer.

J. D. Parent

Terry, L. F. THE FUTURE SUPPLY OF NATURAL GAS. *Petroleum Engr.*, **23A**, 48, 50-52 (1951) July 15.

Present proved reserves of natural gas have been estimated with reasonable precision by the AGA Committee as 180 trillion cubic feet. The total future supply including reserves to be discovered cannot be accurately determined, but based on estimated reserves of oil to be discovered and assuming a figure of 6 MCF of gas per barrel the author concludes that future discoveries of gas will total at least 330 trillion cubic feet making the total future supply of gas 510 trillion cubic feet.

O. T. Bloomer

Industry Expansion

Casper, J. C. LIGHT HYDROCARBONS . . . NATURAL GASOLINE, CYCLING PLANTS RECORD GREATEST PRODUCTION GAIN IN HISTORY. *Oil Gas J.*, **26**, 201 (1951) July 26.

The production at natural gasoline and cycling plants averaged 551,600 bbl. daily for the first half of the year. This is a gain of 78,100 bbl. over the same months last year. L.P.G. now represents 43 per cent of the output of these plants as compared to 22 percent in 1942.

O. T. Bloomer

Duff, D. M. NATURAL-GAS EXPANSION . . . NATURAL GAS CONTINUES EXPANSION DESPITE DIFFICULTIES IN OBTAINING MATERIALS, *Oil Gas J.*, **26**, 208, 211 (1951) July 26.

Increasing difficulties in obtaining line pipe have thus far failed to check the growth trend of the natural gas industry. Utility sales of natural gas for the first four months of this year were approximately 18% higher than the same period last year. Recent trends are in gas storage and the gradual entrance of transmission companies into the field of exploration and

production. Recent figures released by the A.G.A. indicate the approximate $1,400,000,000 will be spent by the gas industry on construction during 1951 and $4,200,000,000 during the four year period 1951-55.

O. T. Bloomer

HOW GAS INDUSTRY PLANS TO SPEND $4.6 BILLION IN NEXT FIVE YEARS. *Gas Age* **108**, 31 (1951) July 19.

Natural gas will get 91% of the money which gas utility and pipe line companies plan to spend for construction and expansion in the period 1951 through 1955. Transmission lines represent the largest single category, with $2.40 billion ear-marked for such construction alone.

A. E. Neumann

NATURAL GAS PIPLINES REACH 125 MORE CITIES. *Gas Heat*, 2, 32 (1951) July. Current pipeline construction will make natural gas available by the end of the year to 125 more cities with populations over 50,000. Despite a record annual consumption in 1950, current proven recoverable resources of natural gas are 5.2 trillion cubic feet more than in 1950.

C. A. Berg

Research

RESEARCH AND DEVELOPMENT AT SIMON-CARVES. *Coke and Gas* (British), **13**, 235-243 (1951) July.

The new research laboratories of Simon-Carves are described. The work to be undertaken has been classified into: chemical analysis and materials testing, research, information service, and technical development. A great proportion of activities is devoted to coal and coke. Of particular interest are the mobile laboratory, the one-third-scale coal washing plant, and the small-scale self-contained coke oven plant. A staff of 55 is contemplated.

W. E. Ball

2. APPLIANCES

Gas Burners

Harrison, J. A. GAS BURNER WITH INTERNAL FUEL DISTRIBUTORS AND VARIABLE FLAME AREA. U.S. 2,560,862 (1951) July 17.

A multiport burner is described that varies the port area automatically with the variations in gas flow. The principle used is resistance to gas flow to distribute the gas flow to definite places. The burner head is divided into sections by baffles within the head. At low gas flow the resistance set up by these baffles forces all the gas through the center section. As the gas flow increases more sections are used to maintain even flow through all ports.

D. L. Nicol

Mun, H. C. GAS BURNER HAVING PROPORTIONAL GAS AND AIR MIXER. U.S. 2,558,057 (1951) June 26.

An atmospheric-type burner is described. This burner is so designed as to afford a double venturi to increase the air entrained. The first venturi has fixed air-shutter and the second venturi has an adjustable air-shutter mechanically linked to the valve controlling the gas rate. By this means the resistance to air entrainment is increased as less gas flows. It is claimed to prevent flash-back when the gas is turned off.

D. L. Nicol

Ray, W. A. (assigned to General Controls Co.) GAS BURNER SYSTEM WITH AUTOMATIC PILOT BURNER CONTROL. U.S. 2,558,267 (1951) June 26.

An assembly is described for the automatic pilot control of intermittent burners. The assembly is comprised of three parts—the pilot burner, spark ignitor and thermocouple indicator. The main burner-valve can only be opened when the thermocouple indicates that the pilot is burning. A special feature of spark ignitors is that in the event of shut-down of pilot, the ignitor can not be energized until a short period after the main burner-valve was closed. This feature allows time to purge out the combustion chamber of unburned gas from the main burner before re-ignition of pilot.

D. L. Nicol

Ignition

Abrams, V. R. and Hollman, P. I. (assigned to Geo. D. Roper Corp.) OVEN LIGHTING SYSTEM. U.S. 2,557,927 (1951) June 26.

An oven lighting system is described for automatic ignition of main oven burners. The principles of operation are that a sub-pilot at the oven burner is ignited by means of a flash tube from a constant burning pilot on the range top. By means of a thermo-electric generator the valve supplying the main oven burner is held closed until the sub-pilot in the oven has been ignited and has heated the thermoelectric generator.

D. L. Nicol

Pressure Regulators

Pommersheim, J. M. WHY PRESSURE REGULATORS HELP DOMESTIC GAS APPLIANCES. *Gas Age*, 108, 31-34 (1951) July 5.

One of the important variables determining rate of input to a burner is the gas pressure. Pressure regulation helps to maintain efficient service of appliances. Since the regulator must be tailored to the job with regard to performance curve and venting, this article shows how these characteristics are effected by regulator design.

D. L. Nicol

Water Heater

Lundstrum, A. W. WATER HEATER. U.S. 2,558, 971 (1951) July 3.

The manual operation of side-arm water heaters is adapted to the advantages of a constant low heat input no greater than that of the pilot on automatic heaters without the complex automatic controls for cycling operation of the main burner. An auxiliary heater designed for an input of 1000 to 3000 Btu/hr. is connected in parallel with the usual side-arm heater. At periods of low withdrawal this heater provides sufficient heat input to maintain the tankwater temperature at the drawoff-pipe. During periods of high withdrawals the usual high-recovery side-arm heater is manually operated.

D. L. Nicol

3. COMBUSTION AND INDUSTRIAL FURNACES

Air Heater Uses

Byron, O. AIR HEATERS AND THEIR USES IN VARIOUS INDUSTRIES. Paper, Am. Gas Assoc., Ind. and Coml. Gas Conf., Washington (1951) April; *Ind. Heating* 18, 1059-1070 (June); 1249-1256 (July); 1437-1444 (Aug.) (1951).

This series deals with gas-fired air heaters placed externally of the enclosure or system being heated. Such heaters have widespread use in conveying heat to the system by convection and may be direct or indirect. Part I (June) treats briefly the principles of convection, and specific applications of air heaters in the manufacture of paper and paper products, and in the printing industry. Part II deals with air heaters in the textile, food, chemical and building materials industries, where the wide variety of products and processes have required specially developed devices for more economical heating. Part III describes the application of air heaters in the can and metal container, television tube, foundry and welding electrode industries. O. P. Brysch

Air Pollution

McCabe, L. C. VENTURI SCRUBBERS ARE GIVING SATISFACTORY SERVICE IN A VARIETY OF FUME REMOVAL AND RECOVERY OPERATIONS. *Ind. Eng. Chem.*, 43A, 105 (1951) July.

Results of the applications of venturi scrubbers to the removal of acid fumes, amine fog, tar and oil fog, and metallic dusts from industrial gases are described. Removals or recoveries up to 99% are reported. A schedule is given of the air pollution section meetings to be held in conjunction with the 12th International Congress of Pure and Applied Chemistry at New York in September. C. E. Hummel

Schrenk, H. H. INDUSTRIAL HYGIENE. RECENT REPORTS DISCUSS NITROGEN OXIDES, SULFUR DIOXIDE, AND SULFURIC ACID MISTS. *Ind. Eng. Chem.*, 43A, 111-113 (1951) June.

Recent reports on the physiological effects of common industrial gaseous contaminants are

briefly reviewed. The toxicity and concentrations are discussed for nitrogen oxides in arc welding, for sulfur dioxide in petroleum refining, and for sulfuric acid mists in laboratory animal studies. The papers of the April 24-27 program of the American Industrial Hygiene Assoc. are listed. O. P. Brysch

Coal-Ash Handling

Jenkins, A. W. PNEUMATIC ASH CONVEYING. *Southern Power and Ind.*, 69, 72-76 (1951) August.

Several pneumatic ash conveying systems are discussed. Designs are given for systems using steam-jet exhausters and motor-driven exhausters of the blower type. Although the steam-jet exhauster has a lower initial cost, the motor-driven exhausters are more efficient and have a higher capacity. The piping recommended is a nickel-alloyed cast iron. Other component parts which are described are: intake fittings, receivers, discharging equipment, filters, and storage bins. The pneumatic system will handle all types of dry ash, fly and clinker. Advantages of the system that are claimed are low initial cost and simplicity of operation.

E. J. Pyrcioch

Coal Particle Combustion

Hoy, H. R. and Whittingham, G. FUNDAMENTAL WORK ON THE COMBUSTION OF SMALL COAL PARTICLES. Review Series No. 101. *Brit. Coal Utilization Research Assoc. Monthly Bull.*, 15, 69-78 (1951) March.

This review is concerned with laboratory and small scale work on the mechanism of combustion of small particles, and describes work on (1) single particles and (2) assemblies of particles. Cenospheres, ignition and combustion of volatile matter, combustion of residual coke, burning time, flame fronts, effect of pressure and effect of sound waves are treated with reference to a bibliography of 48 items from 1922 to date. O. P. Brysch

Combustion Protective Practice

Exley, L. M. DEVELOPMENTS IN USE OF TELEVISION IN POWER STATIONS. *Combustion*, 23, 43-46 (1951) July.

One of the greatest disadvantages of remote centralization of steam generator instruments and controls will be counteracted by the use of television, which can provide the operator with a visible record of instantaneous conditions in the furnace. Such successful application of television at the Port Jefferson Station of the Long Island Lighting Co. is described. It was possible to show (1) that all ignition torches are ignited (2) that coal or oil has ignited and flame is stable (3) that burners are operating properly at any coal or oil rating (4) that burner has extinguished unexpectedly (fuel failure) (5) that conditions leading to explosion may exist. A camera in the furnace roof sends the picture to a viewer on the central control panel.

O. P. Brysch

Gates, C. A. IGNITION AND COMBUSTION PROTECTIVE PRACTICES FOR INDUSTRIAL GAS APPLICATIONS. Paper, Am. Gas. Assoc., Ind. Gas School, Pittsburgh (1951) June; *Ind. Heating*, 18, 1390-1400 (1951) Aug.

The author discusses some of the developments in automatic devices for ignition and combustion protection which have occurred during the wide spread application of gaseous fuels for industrial heating. Gas equipment manufacturers and insurance companies have cooperated in improving both the furnace equipment and the protective devices. Some of the hazards are briefly discussed, such as the sensitivity of the detector to heat from hot brickwork as well as to the flame. The use of the gas flame itself as an electric current conductor has become the dominant principle in protection systems. Photo electric cells and automatic gas analyzers also have some applications. Installation and maintenance of the devices is briefly discussed.

O. P. Brysch

OVEN FLAME FAILURE DEVICES. PART 2 INSTALLATION AND MAINTENANCE. *Ind. Finishing*, (British) 3, 983-986, 988-990 (1951) July.

The second portion of this article deals with the recommended procedure of the installation of pilots in reference to thermal element and of the installation of gas automatic cut-off valves controlled by the thermal element.

D. L. Nicol

Furnace Flow Patterns

Chesters, J. H. FLOW PATTERNS IN FURNACES. *Chem. and Ind.* (British) **24**, 448-456, (1951) June 16.

The flow patterns set up in furnaces by the jet action of burners has been studied with simple two dimensional and three dimensional geometrical shapes. This paper illustrates some of the flow patterns set up by one or more jets into a body of fluid and passage of the fluid out one or more exits. It is claimed that the flow pattern in a water model checks that in a hot furnace.

D. L. Nicol

Gas Burners

Hess, F. O. (assigned to Selas Corporation of America) INTERNAL GAS BURNER. U.S. 2,561,200 (1951) July 17.

An improved form of an internal combustion burner is described. A spiral baffle of refactory materials increases the active combustion surface and the gas stream is directed against this baffle by tangetial entry into the bottom of the burner.

D. L. Nicol

Hess, F. O., Furczyk, A. A. and Henwood, J. B. (assigned to Selas Corp. of America) GAS AND OIL BURNER. U.S. 2,561,795 (1951) July 24.

A fuel-air mixing chamber is described for use on either liquid or gaseous fuel. The purpose of the invention is to provide a mixing chamber that would supply the cup-type radiant burner with a uniform gaseous mixture of fuel and air.

D. L. Nicol

Gas Combustion Research

Keillor, R. D. INDUSTRIAL BURNER NOISES. 2.—THE UNDERLYING CHEMICAL AND PHYSICAL PRINCIPLES INVOLVED. *Gas Times*, (British) **68**, 43 (1951) July 13.

Suggestions are made that the period of noise in an industrial tunnel-burner is affected by the adsorption of hydrogen on the walls. The hydrogen adsorption brings the local temperature high enough to cause a selective reaction to take place. When the hydrogen is adsorbed, the chemical arrangement of the mixture is disturbed and a step is taken toward the end point. As the end point is reached it is possible that the final products are repelled from the catalytic surface in a manner which starts up a cycle of dissociation and association operating at very high frequency.

D. L. Nicol

Stewart, D. G. OSCILLATORY COMBUSTION IN TUNNEL TYPE GAS BURNERS. *Ind. Gas*, **14**, 304, 306, 308, 310 (1951) July.

An investigation was made on tunnel burners to determine why odd harmonics of the fundamental frequency as determined by the tube length were found in pulse-jet engines. Decreased exit size increased the burner chamber pressure and decreased the period of operating frequency.

D. L. Nicol

Turin, J. J., and Huebler, J. ADVANCED STUDIES IN THE COMBUSTION OF INDUSTRIAL GASES—PART II. Report, I.G.R.—59, Comm. on Industrial and Commercial Gas Research, Am. Gas Assoc. (1951) April.

An interim report is given of results obtained on the industrial gas research project I.G.R.—59. Data is shown for the case of detonation-type burners.

D. L. Nicol

Turin, J. J., and Huebler, J. GAS-AIR-OXYGEN COMBUSTION STUDIES. Report I.G.R.—61, Comm. on Industrial and Commercial Gas Research, Am. Gas Assoc. (1951) April.

A literature survey is made of combustion studies as of interest in modern combustion engineering. Factors covered are the use of oxygenated air in combustion of utility gases in regard to theoretical flame temperature, available heat, flame propagation velocities, ignition limits, probable economics of utilization and applications.

D. L. Nicol

Gas Turbines

Mellor, A. G. THE POWER PLANT. *Blast Furnace Steel Plant*, **39**, 566-570 (1951) May.

Operational data, approximate costs and performance characteristics for power generation by gas turbines is given.

C. von Fredersdorff

Viles, P. S. (assigned to Standard Oil Development Co.) SUPPRESSION OF CARBON FORMATION AND CARBONIZATION IN GAS TURBINE AND JET PROPULSION ENGINES. U.S. 2,557,018 (1951) June 12.

The patent relates to a method of suppressing undesirable carbon deposition and carburizing of turbine blades and nozzles by suitable injection of non-metallic sulfides such as hydrogen sulfide or carbon disulfide in the fuel or combustion gases.

C. von Fredersdorff

Yellott, J. I. COAL-BURNING GAS TURBINE STEPS AHEAD. *Power Eng.*, 55, 60-63, (1951) July.

As a result of successful tests on a Houdry coal-fired gas turbine, a 4200 HP Allis-Chalmers locomotive-type turbine has been erected at Dunkirk, N. Y. for early operation on coal. Before sucessful operation of the Houdry unit was obtained, a number of basic units had to be perfected; including a rotary coal feeder, a film-cooled combination coal and oil burner, means for controlling the supply of coal and means for separating flyash from the combustion gases before admission to the turbine blades. The flyash separation program required testing various combinations of centrifugal separators and one difficulty to be overcome was the combustion of carbon in the ash collected. This problem was apparently solved through a combination of lower separators with a bank of modified multiclones all provided with individual blowdown connections. Erosion tests conducted over four 250-hr. periods indicated negligible attack on either rotor or stator blades after removal of the plus-20-micron dust by the revised separators.

C. von Fredersdorff

LOCOMOTIVE COAL-BURNING GAS TURBINE GETS READY FOR TESTING. *Power*, 95, 90-94 (1951) August.

A description of the coal-handling and preparation equipment to be used in the testing of the Allis-Chalmers 3750 HP open-cycle single-shaft gas turbine and regenerator at the Dunkirk plant of American Locomotive Co. is given.

J. J. Guyer

Heat Pump

Dillman, E. J. and Noakes, T. E. (assigned to Detroit Lubricator Co.) HEAT PUMP AND CONTROL MEANS. U.S. 2,558,938 (1951) July 3.

The invention comprises improvements in reversible refrigeration systems and in their control means, with novel arrangements of refrigerant-flow reversing valves which are actuated by an electrical solenoid pilot valve. The latter acts as a safety device, with the solenoid being energized only when a proper presure differential exists between the high- and low-pressure sides.

O. P. Brysch

Freyder, G. G. HEAT-PUMP DOMESTIC WATER HEATER. *Heating, Ventilating*, 48, 77-80, (1951) July.

The new technical development of a heat-pump domestic water heater has developed to the stage of field testing. This paper discusses the last data and experience gained from the test on a 80-gal. heater. The performance factor was 2.14 for a period of 91 days. An interesting characteristic of the heater is the dehumidifying effect of the evaporator coil. Relative humidity values of 60 to 70% were maintained during the summer at the time the heater was being tested. The unit had little or no effect on the basement temperatures.

D. L. Nicol

THE MINISTRY OF FUEL AND POWER'S HEAT PUMP. *Coke and Gas* (British) 13, 248, 249 (1951) July.

Photographs and a flow diagram are given for the heat pump installation in the Royal Festival Hall at the South Bank exhibition of the Festival of Britain. Thames River water is used as the circulating medium and the refrigerant is "Freon 12," dichlorodifluoromethane, which is vaporized in a shell and tube evaporator. The vaporized refrigerant undergoes two stages of compression, the centrifugal compressor being driven by aircraft engines. The compressed vapor passes through an oil separator and then into the condenser from where it flows back to the evaporator. Gas-fuel boilers are used for further heating of the water. The plant is experimental and maximum output is expected to be 90 therms an hour.

E. J. Pyrcioch

Industrial Gas Utilization

Howell, W. F. and Stansfield, W. B. THE USE OF GAS IN THE COTTON INDUSTRY. *Ind. Gas*, **14**, 289-294, 316-320 (1951) July; 327-336, 348-352, Aug: *Gas World* (British) **134**, *Ind. Gas Suppl.* **24**, 70-74, July 21, 82-86, Aug. 18 (1951).

The use of gas as a fuel in the cotton processing industry is discussed. The use discussed is singeing and drying the yarn and finished goods by direct gas flame. Due to critical temperature and placement of the flame it was found necessary to use power-driven gas/air mixing for primary air. Most applications use a 1 to 1½ gas/air mixture except for the Kemp system which uses 100 per cent air/gas mixture. D. L. Nicol

Rocket Fuels

Sittig, M. THE PETROCHEMICAL ENGINEER LOOKS AT ROCKET FUELS. *Petroleum Refiner*, **30**, 114-116 (1951) May.

A brief discussion of the various liquid rocket fuels is presented. A short description of the manufacturing processes of each of three fuels commonly associated with the petroleum and/or synthetic fuels industries is given. These include hydrazine, ammonia, aniline, methanol, ethanol, methylal, nitromethane, furfuryl alcohol and tetrahydrofuran. C. A. Berg

Spreader-Dust Reinjection

Kaiser, E. R. SPREADER DUST RESPONDS TO CONTROLS. *Power*, **95**, 77-79 (1951) August.

Discussion and test data are given for boiler-plant operation with different degrees of stack-dust reinjection. O. P. Brysch

The following articles, the abstracts for which appear on the pages indicated, are also called to your attention:

Coolidge, J. E., PHOTOELECTRIC MEASUREMENTS OF DUST. p. 189

Lewis, B., REPORT OF RESEARCH AND TECHNOLOGIC WORK ON EXPLOSIVES, EXPLOSIONS AND FLAMES. FISCAL YEAR 1950. p. 194

Roberts, A. L., DRYING OF REFRACTORY MATERIAL, p. 203

4. CARBONIZATION AND GASIFICATION

Coal Assay

Cunningworth, B. H. COAL ASSAY ON A SMALL-SCALE TEST PLANT. Inst. Gas Engrs. (British) Comm. No. 384, (Symposium of Short Papers); 3-10 (1951) May.

This test plant was designed to replace two horizontal test units, each of 18 tons/day capacity. The retort consists of an alloy-steel cylinder, holding a 30 lb.-charge, and mounted horizontally in a gas-fired muffle. The recovery train consists of water-cooled condensers, tar fog extractors, scrubbers for ammonia and hydrogen sulfide, gas meters, and gas sample collector. Carbonizing time is 2¼ hrs.

W. E. Ball

Coal Bulk Density

Stahl, C. W. and Kurtz, J. K. DENSITY CONTROL OF COAL CHARGED TO COKE OVENS. *Iron Steel Engr.*, **28**, 93-101 (1951) May.

The control of bulk density of the coal charged to coke ovens at the Sparrows Point, Md. plant of Bethlehem Steel Co. is described in detail. Continuous testing of moisture content, pulverization and bulk density is carried on by a full-time operator, who adjusts the addition of water and oil to a given coal blend to attain a uniform density, so that the highest coal through-put is maintained within the safety limit of expansion pressure. Tabulated hourly, daily and monthly data show the uniformity attained by this system. Former variations of 1 ton/oven-charge have been reduced to 0.10 ton, by the use of an average of 0.16 gal. of a naphthalene base cold-spray oil per net ton coal. Oil additions have greatly reduced the difficulties formerly encountered in handling wet fine coals, and thereby improved battery operations.

O. P. Brysch

Coal Cleaning

Hickey, J. H. (assigned to Great Lakes Carbon Corporation) PURIFICATION OF COAL. U.S. 2,556,496 (1951) June 12.

Removal of mineral constituents from pulverized coal is claimed, by a process comprising

(1) a sink-and-float separation in alkali-metal hydroxide of density sufficient to float the coal substance (2) heating the float-coal with 20-60% alkali hydroxide at 100-200° C. under pressure up to 400 psi, (3) separating the hydroxide and recycling it to the flotation step. (4) washing the coal first with water, then with hydrochloric or mixed hydrochloric-hydrofluoric acids (5) finally washing the acids from the coal with water and then drying. Phenols or alphatic alcohols may be added (0.1 to 10%) during the hot alkali step. Silica, aluminum and iron are removed from the coal which may then be used for electrode or special coke manufacture.

O. P. Brysch

Johnson, H. B. (assigned to The Quaker Oats Co.) METHOD OF CLEANING COAL. U.S. 2,559,076 (1951) July 3.

In this process, coal is sized and separated from mineral matter by passing the coal over a series of rotating drum electrodes. A unidirectional voltage of 4000 to 10000 volts is maintained between each pair of electrodes.

W. E. Ball

Coal Gasification

Cox, H. R. UNDERGROUND GASIFICATION OF COAL. *Endeavour*, **10**, 155-199 (1951) July.

The principles and possibilities of underground gasification are discussed in general and some details are given of the first British experiment at Newman Spinney. The gas quality of the first 10 weeks (test begun July 13, 1950) which averaged 80 Btu/C.F., had dropped to 50 Btu after 4 months. The use of pressure,—pneumatic, hydraulic or explosive—to open natural channels between vertical boreholes in the coal seam is under investigation.

O. P. Brysch

Dent, F. J. THERMAL EFFICIENCY OF COAL DISTILLATION AND GASIFICATION. *Gas J.* (British) **267**, 230-232, 240 (1951) July 25: *Gas World* (British) **134**, 71-76 (1951) July 28: *Gas Times* (British) **68**, 89-103 (1951) July 27.

The thermal consumption in the usual methods of gas making are about 50% of the gas yield in carbonization, 56% in blue gas, and 25% in carburetted water gas manufacture. These losses cannot be radically reduced with present practice. However, the new processes of hydrogenation during distillation, combined with gasification in oxygen and steam and use of fluidized and suspended fuel beds in both gasifying and steam/iron processes in several vessels to produce the necessary hydrogen, offer promise of 80% thermal efficiency. Also, they extend the range of coals available for gas-making, and require less costly plant.

O. P. Brysch

Edmondson, F. C. SUCCESSFUL USE OF COLLIE COAL IN CARBURETTED WATER GAS PLANTS AT PERTH. *Nat. Gas Bull.* (Australian), **15**, 11, 12 (1951) March-April.

The Perth Gas Works is currently producing half its output with three carburetted water gas sets using a sub-bituminous non-coking coal as fuel. Carburetion with oil yields a standard quality gas of high calorific value.

W. E. Ball

King, J. G. THE PRODUCTION OF TOWN GAS FROM WEAKLY-CAKING COALS. *J. Inst. Fuel*, (British) **24**, 147-164, (1951) July.

The reserves of coking coal in Great Britain are decreasing, and the coke industry may have to utilize caking coals now preferred for gas manufacture. This has directed attention towards the utilization of high-volatile weakly-caking coals by the gas industry, and particularly towards the evolution of a process of complete gasification based on such coals. The paper reviews the position regarding the availability of and the demand for coals of different types, and suggests a wider programme of blending to conserve coking coals, but points out the importance of the incidences of transport costs and the free movement of coal types. The present stage of technical advancement of processes of complete gasification is reviewed and the problems facing further advancement are defined. Of the three groups of processes now under development, (a) fixed fuel bed, (b) fluidized fuel bed, (c) entrainment, the first has advanced furthest, and a modified (Lurgi) method is envisaged which utilizes steam and oxygen under pressure to synthesize town gas directly. A second proposal which bears promise of very high volume output is to use a series of fluidized beds also under pressure. The proposals are based on the re-

searches of the Gas Research Board, which are described briefly and which stress the importance of the step in which the simultaneous devolatilization and hydrogenation of coal to methane is achieved. The hydrogen necessary for this step can be produced from a solid residue, through the action of oxygen and steam, but alternative methods should be explored. Processes of entrained gasification are suitable for making synthesis gas, but only that which employs a vortex seems to hold promise for town gas. The incidence of the cost of industrial oxygen is discussed and of long-distance gas transmission for plant located in the coalfields. Alternative integrated schemes are mentioned briefly.

Author's Abstract

Schmidt, L. D. SYNTHESIS GAS FROM PULVERIZED COAL, OXYGEN, AND HIGHLY SUPERHEATED STEAM IS PRODUCED IN PILOT PLANT. *Am. Gas J.*, **175**, 10-14 (1951) July.

Experimental work on the production of gas mixtures of principally CO from pulverized coal, oxygen and superheated steam in three temperature ranges gave the following average results:

Steam Temp.	Reactants/MCF $CO+H_2$.		
°F.	Coal, lb.	Oxygen SCF	Steam, lb.
2904	33.3	171	81.1
1899	37.3	326	42.5
238	42.3	394	29.1

The pilot plant, which consisted in part of a continuous fluidized-bed coal-feeder, Royster pebble-stove steam superheater and a tangentially-fired gasifier vessel, performed satisfactorily in general. Detailed operating results and diagrams are presented.

C. von Fredersdorff

Coal Pipeline

Dougherty, R. W. A SURVEY ON THE HYDRAULIC TRANSPORTATION OF COAL. U.S. Bureau of Mines Report of Investigations 4799 (1951) July.

Final estimates of pipeline costs cannot yet be made, because of insufficient data on pump performance under different operating conditions. These preliminary estimates indicate the economic effects of varying throughput, coal size, pipe size, coal-water ratio, and other variables. It is concluded that coal may be transported economically in pipelines, at costs of $0.38 to $1.91 per ton per 100 miles. A bibliography, with brief abstracts, is appended.

W. E. Ball

Coal Properties

Dryden, I. G. ACTION OF SOLVENTS ON COALS AT LOWER TEMPERATURES II—MECHANISM OF EXTRACTION OF COALS BY SPECIFIC SOLVENTS AND THE SIGNIFICANCE OF QUANTITATIVE MEASUREMENTS. *Fuel* (British) **30**, 145-158 (1951) July.

In this second article (Gas Abs., **7**, p. 52) in a projected series of four, data are presented concerning the action of solvents on coal at room temperature and in a Soxhlet extraction. At a given temperature, the yields after fairly exhaustive extraction by the two methods are substantially the same, even for different specific solvents. From extraction behavior, the coal model apparently consists of a matrix of larger strongly-linked micelles, intimately associated with smaller weakly-bonded micelles. This picture agrees in principle with that of Agde and Hubertus, and Bangham.

W. E. Ball

Inouye, K. A MODERN THEORY OF THE STRUCTURE AND CAKING PROPERTIES OF COAL FROM THE RHEOLOGICAL VIEWPOINT. *J. Colloid Science*, **6**, 190-210 (1951) April.

Experimental data is given for Young's modulus of elasticity E, calculated by Pickett's equation from resonant frequency determinations on 5 x 1 x 0.5 cm. slabs of Japanese coals. Plots are shown of E against moisture content, volatile matter content and volume % of ash. Strongly caking coals show *lowest E* values. The relationship of E to volume % ash varies for different ranks of coal, and resembles that found for fillers in rubber. Benzene-extracted bitumen content and gamma-bitumen content relationships to volume % ash are shown, and are used to explain E in terms of a structural theory.

O. P. Brysch

Lecky, J. A. ADSORPTION OF WATER AND METHANOL ON COAL. *Nature*, **168**, 124-125 (1951) July 21.

These workers at the Synthetic Fuels Branch of the Bureau of Mines point out that the concept of coal as a porous system of high surface area is based mainly upon heats of wetting in methanol, and adsorption isotherms of methanol and water; when the same adsorbate is used, these two methods give approximately the same surface areas. Their data show that surface areas as measured with nitrogen by the Brunauer-Emmett-Teller method are only 0.5 to 2.0% of the areas measured by adsorption of methanol or water. The BET areas were scarcely more than could be accounted for by the external surface areas. These results indicate that the adsorption of polar molecules does not give the surface area, but is related to the number of polar groups present in the adsorbent. Recent studies indicate that water, methanol, and ammonia adsorption are dependent upon oxygen content. In view of these findings, it is felt that present concepts of coal structure should be modified.

W. E. Ball

Smith, E. O. CONVERTING PROXIMATE TO ULTIMATE ANALYSIS. *Power*, **95**, 152 (1951) July.

A chart is shown for conversion of volatile matter and calorific value to carbon and hydrogen, all on the dry, ash-free basis. Good results have been obtained for the majority of coals, exceptions being anthracite, cannel, and coals containing unusual amounts of resins and waxes. A table of ultimate analyses calculated in this manner shows good agreement with actual values.

W. E. Ball

Coke Oven

Brown, C. O. EQUIPMENT AND DESIGN. NEW COKE OVEN DESIGN. *Ind. Eng. Chem.* **43A**, 57, 58, 60 (1951) May.

The first type of oven proposed is to be built of all-welded alloy steel plates; the oven width is 4 in., coke is discharged at the bottom, and flues are horizontal. The second oven, of 8.5 in. average width, is to be built of standard refractories. In comparison with an 18-in. oven of the same throughput, it is estimated that the narrow design will require only 33% of the silica brick, 38% of all the brick, 38% of the space, and comparable percentages of the steel required for the wider ovens.

W. E. Ball

Fluidized Carbonization

Odell, W. W. (assigned to Standard Oil Development Co.) FLUIDIZED PROCESS FOR THE CARBONIZATION OF CARBONACEOUS SOLIDS. U.S. 2,557,680 (1951) June 19.

The invention comprises a 2-zone fluidized system which is used for carbonizing heavy oils, shale, coal, or for generating steam or producer gas. Hot fluidized solids regenerated by oxygen-containing gases are returned to a reaction zone to provide heat for the reaction, then return by gravity to the regeneration zone, which has an upper, waste-gas disengagement compartment and a lower combustion or heating compartment separated by a fixed refractory packing.

O. P. Brysch

Fuel Research

Fieldner, A. C. and Brown, R. L. ECONOMIC SIGNIFICANCE OF RECENT TECHNOLOGIC RESEARCH ON SOLID FUELS. *Mining Eng.* **3**, 597-601 (1951) July.

Excluding synthetic liquid fuels, the total expenditures on coal research and development by all agencies has been estimated at only 0.5% of the value of coal production. Probably the greatest development has taken place in the field of mining mechanization, particularly in the perfection of continuous mining machines. Mine mechanization has increased the necessity for coal washing. Progress has been made in power plant combustion, and smokeless domestic furnaces. The coal-dust turbine may be economically significant in the future. Considerable research has been conducted in the extension of our coking-coal reserves by the use of lower-ranking coals. Research is also in progress on low-temperature gasification, particularly by the fluidized solids technique, and in complete gasification. Attention is being given to the production from coal of a high-BTU gas for supplementing natural gas. About 25% of the national coal research budget is being expended on the synthetic liquid fuels

program. Synthetic gas production, gasification of low rank coals, the Fischer-Tropsch synthesis, oil from shale, and hydrogenation are being investigated.

W. E. Ball

Fieldner, A. C., Gauger, A. W., and Yohe, G. R. GAS AND FUEL CHEMISTRY. *Ind. Eng. Chem.*, 43, 1039-1048 (1951) May.

The history of the fuel industries in America is traced, with particular emphasis upon solid fuels. Sections are devoted to: coal sampling, analysis and testing; origin, petrography, and classification of coal; the chemical nature of coal; combustion; gas investigations; coking and gas making; education; synthetic liquid fuels; and history of the Division of Gas and Fuel Chemistry, American Chemical Society. Present trends indicate an extensive interest in synthetic fuels. W. E. Ball

RESEARCHES ON THE USE OF SOLID FUELS. *Coke and Gas* (British), 13, 215-223 (1951) June.

The Annual Report of the British Coal Utilization Research Association for 1950 lists activities in a variety of fields. Smokeless combustion of bituminous coals, both in closed fireboxes and open fireplaces, was investigated with the aid of an optical density smoke-meter and a thermal precipitator. Efficiency tests on shell boilers indicated that rank of coal was not a significant factor; size had no effect, provided the finer sizes were adequately wetted. Research was also conducted on the downjet burner, crushed coal in the gas turbine, gas producers, flue gas recirculation, deposits in boilers, and flow from burners.

W. E. Ball

Gas Holder

Van Iterson, F. K. T. (assigned to N. V. Hollandsche Constructie Werkplaatsen, Netherlands) DRY GASHOLDER HAVING A BALLAST ACTUATED PISTON. U.S. 2,559,-137 (1951) July 3.

A dry gas holder is claimed, wherein greater stability of the piston is achieved by forming it as a flexible funnel-shaped structure, with the ballasting disposed at the center, so that the center of gravity of the structure is below the level of the peripheral sealing edge of the piston. O. P. Brysch

Gas Plant Design

Redman, M. ANCILLARY PLANT CAPACITY. *Gas Times*, (British) 68, 21-23 (1951) July 13.

A condensed version is given of a review paper which covers the principles of design of ancillary equipment of gas plants, especially in cases where new equipment is to be added. The design factors treated are (1) condensation, as affected by water supply, pumping costs and pressure drop; (2) tar removal, as affected by inlet tar content and gas volume; (3) ammonia washing, as affected by water temperatures, type of washer (multi-stage or tower scrubber); (4) iron-oxide boxes (tower and tray); (5) oil washing, as affected by wetting of packing.

O. P. Brysch

H_2S Removal

Audas, F. G. A CONTINUOUS DRY PROCESS FOR THE REMOVAL OF HYDROGEN SULPHIDE FROM INDUSTRIAL GASES. *Coke and Gas* (British) 13, 229-234 (1951) July.

Removal of H_2S from gas by combination with SO_2 at 85° to 195° F over a catalyst is described and claimed to overcome most of the major disadvantages associated with the use of iron oxide boxes and liquid purification processes. A flowsheet, operating data, and speculative capital and operating cost figures are presented. Sulfur and benzol may be recovered in the application of this process to achieve gas purification.

H. Hakewill

Oil Gas

Stark, V. PROPOSED PROCESS TO PRODUCE GAS OF DESIRED SPECIFICATIONS, LOW COST. *Gas Age*, 108, 24, 25 (1951) July 5.

A process for the recovery of unsaturated hydrocarbons from high B.t.u. oil gases is proposed to produce either a substitute for natural gas or, after dilution with flue gases, a substitute for carburetted water gas. The credits from the by-products supposedly permit the production of utility gas at no cost.

H. R. Linden

Reformed Gas

Barr, F. T. (assigned to Standard Oil Development Co.) PROCESS FOR PRODUCING GAS MIXTURES. U.S. 2,556,835 (1951) June 12.

Hydrogen or H_2-CO mixtures are produced by burning hydrocarbon gases (under 300 psi.) with compressed air in one of more than two regenerative zones arranged for alternate combustion and reforming cycles, then reversing the flow to pass the hydrocarbons (plus steam or CO_2) at 5 to 50 atm., using 3- to 30-minute cycles and temperatures of 1600 to 2500° F.

O. P. Brysch

Refining Byproducts

Dummett, G. A. SOME RECENT ADVANCES IN BENZOLE REFINING. *Gas World* (British) 27, 63-72 (1951) July 7.

From the data presented, the author recommends the following steps in the refining of light oil: the crude light oil is fractionated to remove a heavy naphtha and wash-oil fraction: the crude benzol is washed with caustic soda to remove H_2S; a forerunnings fraction (containing CS_2 and cyclopentadiene) is removed without delay; the stripped lightoil is fractionated before washing, using heat recovery methods where possible; polysulfide reagent is used for residual CS_2 and H_2S removal; for the dilute acid wash, the minimum strength of acid capable of removing thiophene is used; water wash and neutralization must be careful and complete.

W. E. Ball

Souders, M., Jr. (assigned to Shell Development Co.) SEPARATION OF XYLENE ISOMERS BY SOLVENT EXTRACTION. U.S. 2,562,068 (1951) July 24.

The inventor fractionates a mixture containing essentially two isomeric aromatic compounds, such as meta-xylene and para-xylene, by extracting the mixture simultaneously with two solvents which are partially immiscible with each other, and which are chemically inert. One of these is an inorganic liquid such as liquid SO_2, NH_3 or HF which forms a phase rich in para-xylene, and the other is an organic solvent such as pentane, which enriches itself in meta-xylene. The two liquid phases are separated, and the solvents separated from the xylenes by distillation. They may be further purified by redissolving in SO_2, chilling and recrystallizing the meta-xylene.

O. P. Brysch

LESS PRESSURE — MORE PRODUCT. *Chem. Week*, 69, 29 (1951) July 14.

Coal tar distillation is conducted continuously in two flashing operations, the first at atmospheric pressure, removing the light oil, the second at reduced pressure producing a creosote overhead, an anthracene side-stream and a pitch residue. Oil yields are 5% higher than by the pot still system. The process, a German development, is used at Carolineglueck (250 tons/day), at Beckton, England (400 tons/day) and at Uithorn, Holland (150 tons/day.)

C. H. Riesz

Robbins, T. E., Jr., and Hill, W. H. (assigned to Koppers Co., Inc.) THIOCYANOPHENOLS. U.S. 2,562,948 (1951) Aug. 7.

Ammonium thiocyanate and phenols, chemical derivatives of carbonization operations, may be combined to form various thiocyanophenols. This patent describes further treatment of the latter by nitration, ring substitution, and chlorination to form new products useful as pest control agents, pickling inhibitors or dye intermediates.

O. P. Brysch

The following articles, the abstracts for which appear on the pages indicated, are also called to your attention:

Firkin, T. M. REFRACTORY MATERIALS IN GAS MAKING PLANT. p. 208

Lewis, W. K. GASIFICATION OF CARBON. METAL OXIDES IN A FLUIDIZED POWDER BED. p. 192

Pigford, R. L. PERFORMANCE CHARACTERISTICS OF SPRAY-TYPE ABSORPTION EQUIPMENT. p. 204

Martin, J. PRODUCTION OF GAMMA-FERRIC OXIDE HYDRATE AND GAMMA-FERRIC OXIDE. p. 201

Weller, S. KINETICS OF COAL HYDROGENATION. p. 186

Weller, S. CONVERSION OF ANTHRAXYLON. p. 186

5. NATURAL GAS AND NATURAL GAS CONDENSATES

Carbon Black

MORE BLACK: IN THE BAG. *Chem. Week*, 69, 23 (1951) July 7.

Orlon bag filters installed in a carbon black plant at Guyman, Oklahoma, collect 10-15% more product than previous bags and are resistant to attack by the acidic gases.

C. H. Riesz

Compression

Anderson, J. H. NEW LIGHT ON CENTRIFUGAL BOOSTER PERFORMANCE AND ITS RELATION TO GAS PIPE-LINE CAPACITY. *Oil Gas J.*, 50, 325, 327-330, 333-343 (1951) July 26.

This article deals with the operating characteristics of the centrifugal compressor and their relation to pipe line operation. Several example calculations are given. The characteristics are summarized by listing several points: stations should have units connected in series rather than parallel; variable speed drives are required for economy and flexibility; centrifugal units should be designed for ultimate capacity; under light-load conditions it is better to operate the line at full pressure with bypasses to maintain the proper flow.

B. E. Hunt

Arnold, M. L. EXPERIENCES IN DAMPENING PULSATIONS IN COMPRESSOR PIPING SYSTEMS. *Cal. Oil World*, 44, 4-11, 24 (1951) July.

The author lists the possible ill effects of pulsative flow in compressor station systems. Installation of surge chambers without regard to the natural frequency of vibration of a piping system can be more harmful than beneficial in some cases. Determination of the natural frequency through the use of electrical analogues and scale factors in network calculator computations is advised as a guide in the designing and installation of surge chambers.

J. J. Guyer

Oberseider, J. L. COMBUSTION GAS TURBINE—IMPORTANT NEW PRIME MOVER FOR THE GAS PIPE-LINE INDUSTRY. *Oil Gas J.*, 50, 102, 104 (1951) August 9.

Cost, design and engineering evaluation data are given for the use of the combustion gas turbine as a prime mover for gas compressors. Graphs are included giving installation and operating costs for delivered horsepower ratings with and without regenerators. A table is included listing design data for combustion gas turbines of five different manufacturers. Units with rated capacities from 1,850 to 6,500 HP are available.

E. J. Pyrcioch

PIPE-LINE PLAN. EL PASO TO USE GAS TURBINES IN INTERMEDIATE STATIONS. *Oil Gas J.*, 50, 127, 128 (1951) May 31,

In order to increase the system capacity by 300,000 MCF in the parallel 30 and 26 in. lines, El Paso Natural Gas Co. is planning to use 5000-HP. gas turbines in intermediate stations on the Texas-Arizona transmission system. About 10 new stations with 3 units each will be required. Economic studies indicated this plan to be more economical than either looping or large adidtions to existing stations.

O. T. Bloomer

Condensate Recovery

Francis, A. W., Jr. LOW TEMPERATURE SEPARATION AS APPLIED TO GAS-CONDENSATE PRODUCTION. *Oil Gas J.*, 50, 69-73, 84, 86 (1951) July 5.

A process, utilizing the Joule-Thompson principle to obtain low temperature, is used to obtain high hydrocarbon recovery from well gas. Higher percentages of heavier hydrocarbons are recovered. Another advantage of the process is the average 14° F. depression of water vapor dew-point, when the low temperature separator is operated under conditions favorable to hydrate formation. Thus gas of low water-vapor content and low liquid hydrocarbon content can be provided for high-pressure gas transmission lines. The stock liquids recovered possess stability characteristics comparable to those recovered from the conventional system operating at high temperature. A graph for predicting operating temperature from a given well-head flowing pressure is given.

D. C. Gami

King, R. A. GASOLINE PLANT ABSORBER PERFORMANCE. *Petroleum Engr.*, **23C**, 14-16, 18 (1951) July 15.

Absorber operation and efficiency are dependent to a large extent upon the operation of the distillation unit of the plant. A careful fractional analysis of the lean oil is therefore essential in order to determine the loss in the dry gas caused by inproper stripping of the lean oil. This is especially important in the low-pressure plants.

O. T. Bloomer

Thornton, D. P., Jr. NEWEST GAS PROCESSING PLANT. *Petroleum Processing*, **6**, 736-739 (1951) July.

The Elk City, Oklahoma plant produces natural gasoline, crude oil and propane. It is equipped to produce butane and will do so when the demand warrants it. Capacity is now being increased from 100 MMCF per day to 150 MMCF. Gathering is unusual at Elk City, since only protective controls are used at wells, and fittings commonly found on Christmas trees are located at nearby block stations where streams with pressures of 950 to 3200 psi are controlled and reduced to 950 psi. A rich oil de-enthanizer is used and no product de-enthanizer is required.

J. D. Parent

LP Cylinder Testing

Rodgers, C. D. LP-GAS CYLINDER TESTING SYSTEM FOR PROOF PRESSURE METHOD. *LP-Gas*, **11**, 35-37 (1951) July.

The method and equipment used by one company to pressure test LP-Gas cylinders by the recently amended I.C.C. hydrostatic procedure is described in detail. A positive displacement pump fills the cylinder with kerosene after which cylinder nitrogen pressure at 480 psig. is applied to the cylinder. The kerosene is then pumped by compressed air. Details of the procedure and equipment used are given. The procedure has been carefully planned so that one man can perform the entire operation including the removal and reinstallation of the cylinder valves.

O. T. Bloomer

LPG Pipelines

Roach, D. A. PIPE LINE MOVEMENT OF LPG. *Petroleum Engr.*, **23 D**, 11-14 (1951) Reference Ann.

The primary problem to be considered in pipeline movement of LPG is that of tankage or storage facilities at the terminals. The lack of tankage requires the shipment of LPG to be in slugs. Other problems are those of measuring, testing and pumping. B. E. Hunt

LPG Storage

Matheny, F. UNDERGROUND STORAGE FOR LIQUEFIED PETROLEUM GASES. *Petroleum Engr.*, **23 C**, 49-54 (1951) July 15.

The development of salt beds for the underground storage of LPG is reviewed. This and similar methods of underground storage promise to largely eliminate the feast-famine marketing of LPG. O. T. Bloomer

Odorization

Joachim, J. L. HOW DETROIT SOLVED PROBLEMS IN NATURAL GAS ODORIZATION. *Gas Age*, **107**, 19 (1951) July 5.

Laboratory testing data, leak complaints, and the detected leak count were studied together in an odor evaluation program. Low odor intensities were found in certain sections of the distribution system due to dry mains or low gas velocities (during summer months). A controlled-volume, chemical feed pump was found more satisfactory than the conventional by-pass or drip-type odorizers.

C. E. Hummel

Pipelines

Cunningham, E. R. CONTINUOUS PIPELINE CLEANING. HOW EFFICIENCY EXCEEDING 90% IS MAINTAINED ON THE BIG-INCH LINE. *Gas*, **27**, 77-80, 82 (1951) July.

Experience at Texas Eastern Transmission Corp. in increasing the flow efficiency of the "big and little inch" pipe lines are reviewed. The initial problems were the removal of liquids from low points in the line. The efficiency of the line has now been brought up to 90% or greater with frequent running of scrapers. Scrapers that have been used are described. It is necessary to continue the running of scrapers in order to maintain highest efficiency. O. T. Bloomer

King, J. J. LONG-DISTANCE NATURAL GAS TRANSMISSION PIPE LINES. *Mech. Eng.*, 73, 545-548 (1951) July.

After a brief resume of the history of long distance gas transmission lines, present practice is described. B. E. Hunt

Pierce, B. G. SAFETY RULES FOR PIPELINERS. *World Oil*, 133, 239, 240, 242, 244 (1951) August.

A list of rules covering the following subjects is presented: bulldozer, ditcher, dragline and backhoe, and tractor operations; trucks; right-of-way; trench; pipe; welding; cleaning, priming, doping, and wrapping; lowering-in; highway and railroad crossings; sharing; equipment repairs; inflammable liquids; explosives; and first aid.

J. J. Guyer

Production

Bliss, J. E. APPLICATION AND INTERPRETATION OF HYDROCARBON WELL LOGGING. *Oil Gas J.*, 50, 76-79; (1951) August 9.

Hydrocarbon well-logging is a method of testing drilling mud and cuttings for gas and oil content. Oil is detected by fluorescence. A special method of detecting gas is described. Advantages of this method of logging are a decrease in possibility of missing potential pay-sands and a decrease in the number of cores required.

J. D. Parent

Wilson, G. M. GAS REPLACES DRILLING MUD IN SAN JUAN BASIN OPERATIONS. *World Oil*, 133, 128-130, 132, 134, 138, 140 (1951) August.

El Paso Natural Gas Company has developed a drilling technique which employs natural gas instead of drilling mud for the circulating medium. The method has been so successful that it may become standard operating procedure in the drilling or cleaning out of wells which penetrate very porous formations, particularly pay zones, and other intervals where lost circulation commonly occur. The method has been used in drilling the 800 ft. pay section of 5000 ft. wells in the Blanco area of the San Juan Basin in New Mexico. By this procedure the penetration rate has been increased from 150 to 200 feet per day to one half to one foot per minute, and a bit which previously made 80 ft. of hole is now making 300 to 400 feet of hole. A minimum gas velocity of 3000 ft. per minute is required to corry the cuttings and gas rate of 1 - 5 MMcf/d is required. Complete details of the procedure used and the attention needed by the rig and equipment are given. O. T. Bloomer

ALASKA SEARCH TO END; MATERIALS SHORTAGE TO HALT OIL HUNT AT END OF YEAR: NAVY REPORTS $30,000,000 PROFIT FROM ALL RESERVES SINCE 1916. *Oil Gas J.*, 50, 58 (1951) August 9.

The Navy Department plans to terminate exploration activities in Naval Petroleum Reserve No. 4 this year. Two oil fields, one of which is very small, and one gas field were found in this Alaskan work. J. D. Parent

Regulator Stations

McCamish, H. M. CRITERIA FOR SELECTING THE OPTIMUM DESIGN FOR A DISTRIBUTION REGULATOR STATION. PART 1. *Gas*, 27, 27-30 (1951) July.

For the want of established criteria, the design of good regulator stations is not too uniform. Ten fundamental requirements for good regulator stations are listed. The first nine requirements are discussed. B. E. Hunt

Underground Storage

Kornfeld, J. A. GAS-STORAGE GROWTH. *Oil Gas J.*, 50, 41, 42 (1951) August.

The growth in underground storage of natural gas in the last few years is briefly reviewed. $67,000,000 is being spent this year by gas utilities for the development of additional underground storage facilities.

O. T. Bloomer

Spindle, J. E. WHAT ARE THE CHARACTERISTICS OF A GOOD UNDERGROUND STORAGE FIELD? *Gas Age*, 108, 27, 28, 52, 54 (1951) August 2.

This is an introductory article in which the desirable characteristics of an underground storage field are briefly outlined. No general rules as to whether a given reservoir will be economic or not can be given since the conditions and location of reservoirs vary so widely.

O. T. Bloomer

6. PETROLEUM AND SYNTHETIC LIQUID FUELS

Aromatics Recovery

Medcalf, E. C., Hill, A. G. and Vriens, G. N. AROMATICS RECOVERY BY SOLVENT REFINING. *Petroleum Refiner*, 30, 97-100 (1951) July.

Studies of distribution coefficients of various aromatics, alkylated anilines and pyridine derivatives with beta, beta-oxydipropionitrile as a selective solvent have been made. Aromatics can be extracted in high purity from hydrocarbon mixtures, although fractional distillation usually is more effective. Its use for separating close-boiling mixtures such as ethylbenzene and styrene, 2,6-lutidine and picolines (beta and gama) are indicated.

C. H. Riesz

Catalytic Cracking

McKinney, D. D., Hill, D., (assigned to Houdry Process Corp.) PROCESS FOR CONTROL OF HYDROCARBON REACTIONS IN MOVING SOLIDS CONTACTING SYSTEMS. U.S. 2,558,769 (1951) July 3.

In a catalytic cracking process similar to the T.C.C. moving-bed type, liquid feed is sprayed onto an upper surface of freshly fed catalyst while another portion of the clean catalyst is introduced below the surface of the bed.

C. H. Riesz

Orescan, G. (assigned to Universal Oil Products Co., Chicago, Ill.) APPARATUS FOR THE FLUID CATALYTIC CONVERSION OF DIFFERENT HYDRO-CARBON FEEDS. U.S. 2,558,194 (1951) June 26.

A fluidized-catalyst reactor and regenerator are combined in a single-shell arrangement.

C. H. Riesz

Desulfurization

Hepp, H. J. (assigned to Phillips Petroleum Co.) PROCESS FOR SULFUR REMOVAL. U.S. 2,558,137 (1951) June 26.

This invention relates to a catalytic removal of sulfur compounds from hydrocarbon mixtures containing olefins. Silica-alumina type catalyst is used at 150 to 550° F., with pressures in the range of 500 to 2000 psig. Space velocities of 1 to 10 liquid volumes hydrocarbon mixture per catalyst volume per hour are used. Between 4 and 25 per cent of the olefins present react with the sulfur compounds which are then separated from the hydrocarbon mixture as a kettle product of fractionation. The overhead product is substantially sulfur-free.

C. E. Hummel

Montgomery, C. W., Gilbert, W. I., and Hazen, S. M. (assigned to Gulf Research and Development Co.) HYDRODESULFURIZATION OF PETROLEUM HYDROCARBONS. U.S. 2,559,457 (1951) July 3.

Hydrodesulfurization of petroleum fractions is accomplished by passing the hydrocarbon with hydrogen (100 - 1000 psig. total pressure) at temperatures of 750 - 950° F. over a nickel-copper catalyst. The catalyst is prepared on a carrier (alumina) with a nickel content between 5 and 25% by weight and a copper concentration between 5 and 11% by weight of the nickel. Copper, in the specified concentration range, greatly improves the resistance of the contact to powdering on repeated regenerations with air.

C. H. Riesz

Fischer-Tropsch Synthesis

Hess, H. V., and Arnold, G. B. (assigned to The Texas Company) PRODUCTION OF HYDRO CARBONS AND OXYGENATED COMPOUNDS. U.S. 2,558,556 (1951) June 26.

Carbon monoxide and hydrogen are reacted to form valuable products which when subjected to 150-300 psig. pressure separate into a gaseous phase, a hydrocarbon liquid phase and an aqueous liquid phase. The hydrocarbon liquid is distilled and the C_2 and C_3 alcohols, separated from the gasoline fractions, are used to extract oxygenated products from the gas-oil fraction.

C. H. Riesz

Hess, H. V., and Arnold, G. B. (assigned to The Texas Co.) EXTRACTION OF ALCOHOLS FROM THE F-T SYNTHESIS PRODUCT. U.S. 2,558,557 (1951) June 26.

In the synthesis of products from carbon monoxide and hydrogen, the product mixture is separated at atmospheric pressure into a gas phase, a hydrocarbon phase and an aqueous phase. The aqueous phase upon distillation

forms a C_2-C_3 alcohol azeotropic mixture which is used to extract higher (C_4 and up) alcohols from the hydrocarbon fraction. These alcohols are separated. The C_2-C_3 alcohols are extracted by means of a hydrocarbon fraction at 175-350° F. and a pressure of 100-300 psig.

C. H. Riesz

Sweetser, S. B. (assigned to Standard Oil Development Co.) HYDROGENATION OF OXIDES OF CARBON TO PRODUCE HIGH BOILING ALCOHOLS AND LIQUID HYDROCARBONS. U.S. 2,561,244 (1951) July 17.

Long-chain high-boiling alcohols and hydrocarbons are claimed in this 2-zone process of catalytic hydrogenation of carbon oxides; which employs a fluidized, reduced iron powder catalyst at 375° - 425° F. and 15-20 atmos pressure. The conversion to alcohols is maintained at a low rate (from 10 to 50% per pass in this first zone). The second zone of similar iron catalyst, is maintained at 550° - 700° F. and 15 to 30 atmos. pressure, and yields liquid hydrocarbons.

O. P. Brysch

Watanabe, S. BENCH-SCALE STUDIES OF THE FISCHER-TROPSCH SYNTHESIS OVER IRON, NICKEL, AND NICKEL-COBALT CATALYSTS (JAPAN). Bur. Mines, Information Circular 7611 (1951) June.

This report was compiled from two reports (1942) of the Hokkaido Synthetic Petroleum Company. The object was to find a suitable substitute for cobalt and the report has been divided into three parts-nickel catalysts, nickel cobalt catalysts and iron catalysts. Two nickel catalysts were developed as follows: Ni-Mn-kaolin-kieselguhr (100:20=100=200) and Ni-Mn-ThO_2-kaolin-kieselguhr (100:20:1=100=200). Acid-washed kieselguhr is essential; the manganese content is necessary to obtain reduction at 750° F. Three nickel-cobalt catalysts were developed as follows: Ni-Co-Mn-ThO_2-kaolin-kieselguhr (70:30:15:3=25=200); Ni-Co-MgO-ThO_2-kaolin-kieselguhr (50:50:8:5=50=200) and Ni-Co-MgO-ThO_2-kaolin-kieselguhr (30:70:8:5=25=200). These mixed nickel-cobalt catalysts produced a considerably higher yield of liquid products than did the nickel catalysts. In the third part of the report, an iron catalyst was used, Fe-Cu-Mn-H_3BO_3-K_2CO_3-kieselguhr (100:25:2:20=7=125). In tests at a pressure of approximately 150 psig., a single-pass test continued for 20 days while results of a 66-day test with gas recirculation are also presented. The latter test was continued to a total of 100 days, indicating that an iron catalyst can be used for an extended operating period.

C. H. Riesz

Hydrogenation

Weller, S., Pelipetz, M. G. and Friedman, S. KINETICS OF COAL HYDROGENATION. *Ind. Eng. Chem.*, 43, 1572-1575 (1951) July.

Asphalt, defined as material soluble in benzene but insoluble in n-hexane, was hydrogenated in batch autoclave tests at about 3000 and 6000 psig. The conversion of asphalt obtained from pilot plant hydrogenation of coal was found to be of first order with respect to asphalt remaining. The activation energy measured at 800 - 825° F. was approximately 65,000 Btu/lb-mole and a large temperature coefficient indicated that a chemical reaction is rate-controlling. Of the asphalt converted, 92% forms oil and 8% produces hydrocarbon gases.

C. H. Riesz

Weller, S., Pelipetz, M. G. and Friedman, S. CONVERSION OF ANTHRAXYLON. *Ind. Eng. Chem.*, 43, 1575-1579 (1951) July.

Hand-picked bituminous coal anthraxylon was subjected in batch autoclave tests to hydrogenolysis in the presence of tin sulfide-ammonium chloride catalyst with an initial cold hydrogen pressure of 2500 psig. The conversion of coal to liquid and gases was found to be first order with respect to coal remaining. The results indicate that the hydrogenation of coal is described by the reaction scheme, coal-asphaltene-oil, both reactions being kinetically first order with water and gas as minor side reaction.

C. H. Riesz

Liquid-Vapor Equilibria

Othmer, D. F., Ten Eyck, E. H., and Tolin, S. EQUILIBRIUM FLASH VAPORIZATION OF PETROLEUM CRUDE OILS OR FRACTIONS. *Ind. Eng. Chem.*, 43, 1607-1613 (1951) July.

The process engineer frequently requires

vapor-liquid equilibrium data for the design of equipment to separate multi-component hydrocarbon mixtures. Data for the more complex systems are usually expressed as a family of isobaric curves on a plot of per cent vaporized versus temperature. A new method and a new type of apparatus for the study of these vapor-liquid phase relations are presented which are believed to be superior to the regular equipment currently in use. This has been accomplished by the design and use of a modified recirculating equilibrium still of the type used by numerous investigators with binary and ternary systems. The unit has been thoroughly evaluated at atmospheric and subatmospheric pressures for equilibrium conditions, entrainment, and pressure drop. Tests on a variety of petroleum stocks have shown this unit to be highly satisfactory for the determination of equilibrium vaporization curves, throughout practically the entire range of ratios of per cent volatilized.

Author's Abstract

Reamer, H. H. and Sage, B. H. VOLUMETRIC AND PHASE BEHAVIOR OF PROPENE-PROPANE SYSTEM. *Ind. Eng. Chem.*, **43**, 1628-1634 (1951) July.

The processing of petroleum products involves the separation of propene and propane by fractionation, and a detailed knowledge of the phase behavior of the propene-propane system is useful. Compositions of the coexisting phases of this system were investigated at five temperatures between 10° and 190° F. Equilibrium ratios were established and the data were smoothed by use of the quotient of the actual equilibrium ratio and that predicted from Raoult's law. At the lower pressures uncertainty in measurement of this variable limited the accuracy of the results, whereas at the higher temperatures the measurements of composition were the primary source of error. The molal volume of two mixtures was determined at seven temperatures between 10° and 400° F. for pressures from 200 to 10,000 pounds per square inch. The data indicate for propane progressively smaller deviations from Raoult's law as the temperature is decreased, but show a minimum deviation for propene at approximately 100° F. The maximum deviation was for propane at 190° F. and at compositions near pure propene. Only small deviations from additive volumes were found throughout the entire range of pressures and temperatures investigated. The maximum deviation near the critical states of the system was 1.7% for a mole fraction propane of 0.6289 at 600 pounds per square inch and 220° F.

Author's Abstract

Reilly, P. M. A DIRECT METHOD FOR SOLVING FLASH EQUILIBRIUM CALCULATIONS. *Petroleum Refiner*, **30**, 132-136 (1951) July.

A direct mathematical method is derived for solving the flash equilibrium equation. Special mathematical functions involving only the vaporization equilibrium constant (K) are defined. Tables are presented which enable the values of the functions to be determined from the value of K. A direct solution for the value of the mol fraction of liquid phase is then possible using the values of the special function. The first solution is approximate only, since an infinite-series expansion in which terms higher then the second are dropped is involved in the method. In most cases the first answer is well within the error of the data. A method of applying a correction is also provided which gives an answer of sufficient accuracy for practically all cases.

O. T. Bloomer

Oil-Gas-Water Permeability

Caudle, B. H., Slobod, R. L. and Brownscombe, E. R. FURTHER DEVELOPMENTS IN THE LABORATORY DETERMINATION OF RELATIVE PERMEABILITIY. *J. Petroleum Technology*, **3**, 145-158 (1951) May.

This paper describes the apparatus and technique for the solution gas and the dynamic displacement methods and presents a routine procedure for obtaining oil-gas and water-oil relative permeability data. Theoretical and experimental considerations are presented to show that the end-effect commonly associated with the dynamic flow mechanism is extremely small where constant rates are employed in the flowing phase. An effect of flow rate on relative permeabilities obtained by the dynamic system is found only when gas is one of the flowing phases and this effect is ascribed to a form of channeling in the capillary system. The apparatus and procedures used to obtain

relative permeability data with three phases flowing are described and some preliminary results of the use of this method are shown.

Author's Abstract

Reforming Processes

Kirkbride, C. G. HOUDRIFORMING—A CONTINUOUS PROCESS FOR REFORMING PETROLEUM NAPHTHAS. *Oil Gas J.*, 50, 60-62 (1951) July 5.

Dual-function catalysts have been developed for the Houdriforming process. The catalysts, not disclosed, are selective for dehydrogenation of C_6 using naphthene, dehydro-isomerization of alkyl cyclopentanes and isomerization of paraffins. The catalysts are not poisoned by sulfur compounds and, although the process is nonregenerative, the catalysts may be regenerated in place. The process gases contain more than 97% hydrogen. The process is now in an advanced pilot-plant stage of development toward commercial scale operation.

C. H. Riesz

Shand, E. W. (assigned to Sinclair Refining Co.) PROCESS AND APPARATUS FOR THE CATALYTIC CONVERSION OF HYDROCARBONS. U.S. 2,560,899 (1951) July 17.

This invention claims that improved gas-solid contact for vapor-phase catalysis of oils is obtained by adding the catalyst to the charge-oil while in the liquid state and under pressure, then suddenly reducing the pressure whereby the oil flashes to vapor which carries the suspended catalyst to a dense-phase fluidized bed in a reactor.

O. P. Brysch

Scale Removal

Jones, E. N. CORROSION AND SCALE CONTROL. *World Oil*, 133, 204, 208, 210 (1951) August.

Acids have many uses during the producing life of a well other than the usage at the completion. Acids have been used to remove scale, clean well bores, and retrieve cemented liners. Several methods of using acids are illustrated and discussed. Scale removal with the use of a chemical compound is also discussed.

B. E. Hunt

Thermal Cracking

Bowles, V. O., and Schutte, A. H. (assigned to The Lummus Co.) METHOD OF HYDROCARBON CONVERSION TO LOWER BOILING HYDROCARBONS AND COKE. U.S. 2,561,334 (1951) July 24.

The inventor proposes a scheme of cracking heavy liquid hydrocarbons into lighter products by feeding the liquids to the top section of an unaggitated, downwardly-moving column of hot granular coke or other solids. In the bottom section of this column the coked oil residue formed upon the particles of the bed is burned off by air injected into the bed, and the combustion gases are withdrawn through internal collector-hoods by suction. Temperature of the moving solids is adjusted by rate of travel and by cooling coils, and the solids are returned by elevator to the cracking section at the top of the column. Injection of purge-gas is used to separate the cracking and combustion sections.

O. P. Brysch

7. ANALYTICAL METHODS AND TESTS

Carbon Determination

Thorn, J. A. and Shu, P. A NEW APPARATUS FOR RAPID CARBON DETERMINATION BY WET COMBUSTION. *Can. J. Chemistry*, 29, 558-562 (1951) July.

A simple, compact apparatus has been designed for the estimation of carbon in organic materials by a wet combustion procedure employing the Van Slyke-Folch oxidation liquid. Oxidation of the sample and absorption of the resultant carbon dioxide take place under reduced pressure. The carbon dioxide is transferred from the oxidation flask by diffusion and is absorbed in stirred sodium hydroxide, the excess alkali being determined by titration with hydrochloric acid after addition of barium chloride. Sample containing from 0.3 mgm. to 15 mgm. of carbon may be analyzed with a probable error of 0.35%. Volatile compounds in aqueous solution may also be analyzed. Sulphur, nitrogen, and halogens do not interfere. Determinations were made on the following compounds: Sucrose, succinic acid, cysteine hydrochloride, cholesterol, stearic acid, and acetone. An analysis requires from 20 to 25 minutes.

Author's Abstract

CO Determination

CARBON MONOXIDE DETECTION AND ESTIMATION. *Gas World* (British) **134**, 60 (1951) July 21.

Improvements in design and advantageous applications of a previously described simple and rapid colorimetric test for carbon monoxide are reviewed. In use, gas is aspirated through a tube containing silica gel for removing interfering substances and a palladium compound for detecting and estimating CO content by color change from yellow to black. The time required for completion of a test is two minutes; and it is claimed that the results obtained can be relied upon implicitly.

H. Hakewill

Dust Determination

Coolidge, J. E., Schulz, G. J. PHOTOELECTRIC MEASUREMENT OF DUST. Instruments, **24**, 534, 544, 578, 579, 580 (1951) May.

Available methods for measuring smoke density are described. The photoelectric absorption meter used at Pennsylvania State College is discussed in detail. The original one-phototube model is described. The more-sensitive two-phototube model, together with its bridge circuit, is described in detail. The factors associated with sampling are discussed. A brief theory of light absorption by dust loading is presented.

Author's Abstract

Fractionation

Donnell, J. W. and Turbin, K. SAVE TIME WITH SYSTEMATIC METHOD FOR DISTILLATION CALCULATIONS. *Chem. Eng.*, 58, 112-115 (1951) July.

Multicomponent distillation calculations are made less time consuming by systematic arrangement in tabular form so that each calculated value is of use in subsequent calculations. Equations on which the calculations are based are derived. The authors feel that with certain (unspecified) adaptions, automatic calculating machines may be used to further reduce time consumption.

C. A. Berg

Thornton, J. D. AN IMPROVED TYPE OF VAPOUR-LIQUID EQUILIBRIUM STILL. *J. Applied Chem.* (British) **1**, 237-239 (1951) June.

A design is presented for a new type of vapour-liquid equilibrium still. This incorporates separate liquid- and vapour-sample traps, the latter being vacuum-jacketed. The apparatus has proved satisfactory for investigating the type of system encountered in the extractive distillation process, where heterogeneous condensates occur a few degrees below the equilibrium temperature.

Author's Abstract

High Temperature Pyrometry

Marsh, J. S. SIGNIFICANCE OF AIR TEMPERATURE IN OPEN HEARTH OPERATION. *Ind. Heating*, **18**, 1032-1042 (June); 1224-1232, 1326-1328 (July) (1951).

The author discusses the importance of theoretical flame temperature and the influence of the sensible heat of the air in open-hearth furnace operation. Measurement of the preheated air temperatures by a high-velocity thermocouple was studied. Comparisons with bare thermocouples, optical pyrometer readings on walls, and spectral-line-reversal temperatures are discussed. Air leakage in the regenerators and furnace was found to contribute most to low air temperatures and "cold" slow operation.

O. P. Brysch

Percy, J. W. COMPARISON OF METHODS FOR MEASURING TEMPERATURE OF MOLTEN METALS. *Instruments*, **24**, 766, 768 (1951) July.

Two methods in common use for measuring the temperature of molten metals are (1) the blow tube pyrometer consisting of an air- or nitrogen-purged immersion pipe in which is mounted an optical pyrometric element and (2) the immersion thermocouple comprising a platinum-platinum-rhodium couple insulated with a refractory casing, the extreme end of which contains a silica immersion tube for the thermocouple tip. Blow-tube pyrometers possess the advantages that more readings may be taken before maintenance is required, are

very accurate if an inert gas purge is used, and are less expensive to operate than immersion thermocouples. The immersion thermocouple has a fragile tip which is easly broken, requires more maintenance in general, but is easier to handle because of its light weight. The accuracy of both methods is well within the ±20° F. ordinarily set in open-hearth works and initial costs of either method are approximately equal.

C. von Fredersdorff

Veiock, L. H. A THERMOCOUPLE SYSTEM FOR MOLTEN-METAL TEMPERATURE MEASUREMENT. *Instruments*, 24, 769, 770, 794 (1951) July.

Construction and operational details are given for an immersion thermocouple and recorder for use in measuring molten steel temperatures as required in the open hearth furnace.

C. von Fredersdorff

H_2S Determination

Cooper, J., and Thomas, H. H. CONTINUOUS DETERMINATION OF SMALL CONCENTRATIONS OF HYDROGEN SULPHIDE IN TOWN AND OTHER GASES. *Gas World* (British) 134, 47-52 (1951) July 21.

The design and construction of a continuous automatic device for determining and recording H_2S in utility gases are described in detail. In operation gas is passed through a restricted area of a bibulous-paper tape previously treated with lead acetate-glycerine solution, and the density of the lead sulfide stain produced thereon is photoelectrically measured by employing transmitted light and is recorded on a strip chart.

H. Hakewill

Meter Prover

Burch, E. P. (assigned to Electronic Tester of Gas Meters, Inc.) GAS METER PROVER APPARATUS. U.S. 2,555,730 (1951) June 5.

Means are described for improving the operation of conventional bell-type gas-meter provers by providing automatic electrical controls for starting and stopping the flow of calibrating gas. Accuracy in gas-meter testing with this device is said to be increased by reducing the opportunity for human error to a minimum.

H. Hakewill

Burch, E. P. (assigned to Electronic Tester of Gas Meters, Inc.) GAS METER PROVER APPARATUS. U.S. 2,561,904 (1951) July 24.

This invention consists of the usual type of calibrated-bell prover, from which the flow of air to the meter under test is controlled by magnetic valves actuated through a rotary contact switch which is operated mechanically by the movement of the bell.

O. P. Brysch

Oil Ash

Morgan, L. O. and Turner, S. E. RECOVERY OF INORGANIC ASH FROM PETROLEUM OILS. *Anal. Chem.*, 23, 978, 979 (1951) July.

Ashing techniques in common use for the determination of inorganic ash components in petroleum oils may lead to volatilization and combustion losses, thereby contributing to analytical error. This study was carried out in an attempt to evaluate the significance of the possible errors. Radiochemical techniques were used to trace the metallic constituents of contaminants added to several typical oils through the standard combustion and ignition processes. Essentially complete recovery of the iron, calcium, and sodium tracers was obtained when they were added to the oils as naphthenates, salicylates, and inorganic salts, if combustion was carefully controlled and ignition was carried out at less than 550° C. Traces of water and other sources of surface turbulence during combustion led to losses. It was concluded that properly controlled combustions and ignitions yield ash samples representing quantitative recovery of metallic contaminants from petroleum oils, if the additives used are considered to be typical of those normally occuring as contaminants.

Author's Abstract

Oxygen Determination

Gouverneur, P., Schreuders, M. A., and Degens, P. N., Jr. THE DIRECT DETERMINATION OF OXYGEN IN ORGANIC COMPOUNDS. INVESTIGATION OF SOME SOURCES OF ERROR IN THE SCHUETZE-UNTERZAUCHER CARBON REDUCTION METHOD. *Analytica Chimica Acta*, 5, 293-312 (1951) June.

Experience with the Unterzaucher modification of the Schuetze carbon reduction method

showed an inordinately high blank value, particularly with substances low in oxygen. These difficulties were overcome by substituting the gravimetric determination of carbon dioxide for the volumetric oxidation of carbon monoxide with iodine pentoxide, and by improved purification of the transport gas. The small error remaining is probably due to slow removal of adsorbed oxygen from the carbon packing.

W. E. Ball

Particle Size Measurement

Hawksley, P. G. THE PHYSICS OF PARTICLE SIZE MEASUREMENT: PART I. FLUID DYNAMICS AND THE STOKES DIAMETER. Brit. Coal Utiliz. Res. Assoc. Monthly Bull., 15, 105-146 (1951) April.

This very comprehensive review indicates the great growth of interest and activity in the study of particle size. The several concepts of size are first discussed. The various methods of particle size measurement are treated under the classifications of (1) microscopic method, (2) separation in a fluid, (3) sedimentation methods, (4) separation in a moving fluid, (5) separation in an electric field, (6) averaging methods. The shape of particles is then discussed from the standpoints of (1) sphericity and circularity factors (2) measurement and (3) significance. The purpose of a particle size measurement,—in characterizing either a product or a process—is described by interpretating such measurements in terms of industrial processes. Motion of particles and fluids is treated extensively under the 3 conditions of (1) low particle concentration, (2) high particle concentration with mutual interference, (3) motion in packed beds, with remarks on Stokes drag, wall effect, shape factor, diffusion laws, and bed permeability. Tabulations of definitions, methods of measurement, sphericity, Reynolds number, wall factors, discontinuity corrections, particle shape, concentrations of particles, diffusion of particles, bed permeabilities, as reported by various investigators, also are used as a means of classifying the findings in more than 200 references.

O. P. Brysch

Ivey, F. E., Jr. THE PARTICLE SIZE ANALYSIS OF FLUID CRACKING CATALYSTS. PART I. *Petroleum Refiner*, 30, 99-103 (1951) June.

Because of the wide range in particle diameter, both screening and sub-sieve analyses were required. In the screen analysis, a weighed sample was placed on the top sieve of a nest of U.S. 40, 60, 80, 100, 140 and 200 sieves, which were shaken for a specified time in a Ro-Tap machine. The percentages on the finer screens were found to be dependent upon the procedure used. The specifications adopted after statistical analysis of extensive data included a sample weight of 25 gm., shaking time of 30 minutes, and humidification for 2 hours with air, at 60% relative humidity. It was not possible to attain precision of less than 3% on the 200-mesh screen because of variations in the screens; matched screens tested by the manufacturer did not materially improve the precision. Microscopic count showed that the screen analyses were 4.4% high at the 100-mesh level and 14.5% high at the 200-mesh level. The inherent error with screens having the normal percentage of oversize openings was thought to be responsible for this difference.

W. E. Ball

Ivey, F. E., Jr. IMPROVED METHODS FOR THE PARTICLE SIZE ANALYSIS OF FLUID CRACKING CATALYSTS. PART II. *Petr. Refiner.*, 30, 141-145 (1951) July.

In Part II of this three-part article, the precision of the Roller test as applied to fluid cracking catalysts is shown to vary from ±2.1 percent at the 0-20 micron level to ±7.6 percent at 80+ micron level. Data are also presented to indicate the lack of accuracy of the method. The causes of these undesirable characteristics are discussed together with the means used to improve them. The use of air of 60 percent relative humidity at a 9 liter per minute rate, and a fritted glass aeration tube were found to increase the precision to ±0.6 percent at the 0-20 micron level and ±1.7 percent at the 80+ micron level, mainly by eliminating attrition, agglomeration, and electrostatic retention. Humidification of the sample prior to testing was found to be of no benefit.

Author's Abstract

Spectrographic Analysis

Wark, W. J. SPARK ANALYSIS OF SEMI-MICROSAMPLES. *J. Opt. Soc. Amer.* **41**, 465-467 (1951) July.

A new method of mounting semi-microsamples for spectrographic analysis is described. The method is very flexible and is particularly adapted to those procedures involving limited samples. An appreciable decrease in the cost of high purity spectrographic materials can be obtained. The method can be applied to arc or spark techniques without modification.

Author's Abstract

Sulfur Determination

Siegfriedt, R. K., Wiberley, J. S. and Moore, R. W. DETERMINATION OF SULFUR AFTER COMBUSTION IN A SMALL OXYGEN BOMB. *Anal. Chem.*, 23, 1008-1011 (1951) July.

A 40-ml. oxygen bomb was used for the combustion of 2 to 200 mg. samples of organic compounds. Sulfate was determined in the bomb washings by titration with barium chloride solution, using tetrahydroxyquinone as indicator. A magnetic stirrer and color filter were helpful in obtaining reproducible endpoints. Correction of reagent volume for indicator error eliminated the former limitation of a minimum titration of 3 ml. Single determinations required less than one hour of elapsed time, and sulfur percentages compared favorably with theoretical values and those obtained by ASTM methods.

W. E. Ball

The following articles, the abstracts for which appear on the pages indicated, are also called to your attention:

Bliss, J. E. APPLICATION AND INTERRUPTATION OF HYDROCARBON WELL LOGGING. p. 184

Cepriano, L. D. OXYGEN MEASUREMENT AS A GUIDE TO COMBUSTION EFFICIENCY. p. 206

Cunningworth, B. H. COAL ASSAY ON A SMALL-SCALE TEST PLANT. p. 176

Smith, E. O. CONVERTING PROXIMATE TO ULTIMATE ANALYSIS. p. 179

STAHL, C. W. DENSITY CONTROL OF COAL CHARGED TO COKE OVENS. p. 176

8. GENERAL AND PHYSICAL CHEMISTRY

Calorimetry

Thomas, A. AN ISOTHERMAL CALORIMETER FOR MEASURING LOW RATES OF HEAT EVOLUTION OVER LONG PERIODS. *Trans. Faraday Soc.* (British) **47**, 569-572 (1951) June.

A low-temperature calorimeter measuring the evolution of heat over long periods of time at the rate of about one calorie per hour is described. Naphthalene melting at 80° C. is kept at this temperature by means of a thyratron electronic circuit controller. The controller is connected to the heater regulating the oil-bath temperature. As heat is evolved the naphthalene melts thus increasing in its volume. The change in volume is measured on a capillary tube. A direct relation between change in volume and beats of evolution may be obtained.

S. Mori

CO_2 Compressibility

Kendall, B. J. and Sage, B. H. THE VOLUMETRIC BEHAVIOUR OF CARBON DIOXIDE. *Petroleum* (British), **14**, 184-186 (1951) July.

The volumetric properties of carbon dioxide are tabulated for the temperature range 40 to 460° F. at pressures 200 to 10,000 psia. The properties were calculated from data in the literature as well as from new data obtained by the authors. The new data covers the ranges of 5,000 to 10,000 psia at all temperatures and 0 to 10,000 psia for temperatures of 340° and 460° F. The data are presnted as specific volume in cubic feet per pound made with the values of the compressibility factor ($e = \frac{nv}{rt}$) also tabulated.

O. T. Bloomer

Carbon Gasification

Lewis, W. K., Gilliland, E. R. and Sweeney, M. P. GASIFICATION OF CARBON. METAL OXIDES IN A FLUIDIZED POWDER BED. *Chem. Eng. Progress*, **47**, 251-256 (1951) May.

The production of carbon dioxide from carbon by the oxygen-carrier technique was studied in fluidized beds of pulverized coke mixed with iron ore and copper-oxide on silica gel. Equi-

librium data obtained for the gasification reactions 3 Fe_2O_3 + CO → 2 Fe_3O_4 + CO_2 and 4 C u O → 2 Cu_2O + O_2 are in apparent agreement with available thermodynamic data. The experimental results indicated that no signficant direct solid—solid interaction takes place, but that the probable mechanism of reaction may be based on the simultaneous equations C + CO_2 → 2 CO; CO + metal oxide → CO_2 + metal. Conversion data show that it may be feasible economically to generate CO_2 using hematite iron ore as the oxygen carrier, but that a further investigation of the process is recommended before application may be successful.

C. von Fredersdorff

Carbon-Oxygen Isotopes

Grosse, A. V. and Reid, A. F. (assigned to Sun Oil Company, Philadelphia) ISOTOPE CONCENTRATION PROCESS. U.S. 2,559. 152 (1951) July 3.

The use of sodium silicate and allied catalytic materials is described for the concentration of oxygen and carbon isotopes in solutions of carbon dioxide, carbonic acid and bicarbonate ion in water.

S. Katz

Computation

Bainbridge, J. R. FACTORIAL EXPERIMENTS IN PILOT PLANT STUDIES. *Ind. Eng. Chem.* 43, 1300-1306 (1951) June.

The experimental program described was chosen to investigate the effects of reaction temperature, throughput, and gas concentration upon product strength for a catalytic gaseous synthesis. Tests were carried out at all combinations of high and low levels of the factors, requiring eight runs. Duplicates varied the required runs to sixteen. A detailed description is given of the methods used in statistical analysis of the data. It was indicated that temperature and gas concentration significantly affected the results, while the effect of throughput was negligible. The experimental plan proved sufficiently versatile to deal with such uncontrollable variables as gas purity, and to show the magnitude of the experimental error.

W. E. Ball

Daniel, C. DESIGN OF EXPERIMENTS FOR MOST PRECISE SLOPE ESTIMATION. *Ind. Eng. Chem.* 43, 1298-1300 (1951) June.

The methods for calculating the slope and the variance of the slope of a straight line fitted by the method of least squares are given. In the design of experiments, if the relation between x and y is known to be linear, maximum precision will be attained by taking half the measurements at each end of the measurable range. Equal bunching of points is about three times as effective as equal spacing. When the precision of y varies with x, the points should be bunched at two values of x, but not necessarily in equal number or as far apart as possible.

W. E. Ball

Goldberg, E. A. (assigned to Radio Corporation of America) POLYNOMIAL EQUATION SOLVER. U.S. 2,558,430 (1951) June 26.

The patent relates to simplication of an electrical computer for obtaining the roots of polynomials of the form $a_o + a_1 x + a_2 x^2 + \text{-----} + a_n x^n = 0$.

C. von Fredersdorff

Diffusion

Boyd, C., Stein, N. and Rumpel, W. F. AN INTERFEROMETRIC METHOD OF DETERMINING DIFFUSION COEFFICIENTS IN GASEOUS SYSTEMS. *J. Chem. Phys.*, 19, 548-553 (1951) May.

The diffusion of H_2 and N_2 in various gases was studied in a new type of apparatus. The individual gases were contained in two half-cells, which were slid over one another, and the rate of diffusion measured by observing the change in refractive index of the gas mixture with an optical interferometer. Diffusion coefficients obtained by this method were reproducible and agreed with the calculated values of Hirschfelder, Bird, and Spatz.

W. E. Ball

Schwertz, F. A. and Brow, J. E. DIFFUSIVITY OF WATER VAPOR IN SOME COMMON GASES. *J. Chem. Phys.*, 19, 640-646 (1951) May.

From the measured rates of diffusion of water vapor from a capillary tube into pure hydrogen, helium, methane, ethylene, nitrogen, oxy-

gen, and carbon dioxide, the mutual coefficients of diffusion have been determined. Measurments were made at 34°, 56°, and 80° C. and at atmospheric pressure. The coefficients of diffusion are only a few percent lower than values calculated by the kinetic theory assuming the molecules are rigid spheres. The theory of the experimental method is presented in detail and a description of the apparatus is given.

O. T. Bloomer

Winter, E. R. DIFFUSION PROPERTIES OF GASES. PART IV. THE SELF-DIFFUSION COEFFICIENTS OF NITROGEN, OXYGEN AND CARBON DIOXIDE. *Trans. Faraday Soc.* (British), 47, 342-347 (1951) April.

The diffusion rates have been measured, by mass spectrometer, of the molecules ^{14}N ^{15}N, ^{16}O ^{18}O into isotopically-normal nitrogen, oxygen and carbon dioxide respectively. Measurements have been performed at 0° C. and 45° C. The diffusion coefficients are, for oxygen and nitrogen, in good agreement with the predictions of the Chapman-Enskog kinetic theory of gases using the Lennard-Jones 12:6 model. The experimental results for carbon dioxide are a little higher than the theoretical figures.

Author's Abstract

Electron Microscopy

Philpott, D. E. PORTRAIT SHADOW- CASTING. *J. Applied Phys.*, 22, 982-988 (1951) July.

A back shadowing technique for electron microscope specimens is explained. Improved picture clarity and specimen stability are claimed.

D. V. Kniebes

Flame Research

Lewis, B. REPORT OF RESEARCH AND TECHNOLOGIC WORK ON EXPLOSIVES, EXPLOSIONS, AND FLAMES — FISCAL YEAR 1950. Bur. Mines, Report of Investigations 4793 (1951) June.

The report of work completed for the fiscal year 1950 at the Bureau of Mines on combustion is presented. Subdivisions of notes are: (1) Predicting burner performance with interchanged fuel gases by flame-stability diagrams for single port burners on lighting, flashback, and yellow tip. (2) Table of thermodynamic properties at equilibrium of gas mixtures composed of carbon, hydrogen, nitrogen, and oxygen. Numerous calculations have been made with the ENIAC to tabulate these properties from 1000° to 5000° K., and from 0.1 atmosphere to pressures great enough to include those of interior ballistics. Assumed products were CO, CO_2, H_2, H_2O, N_2, O_2, OH, NO, H, N, O, NH_3, CH_4. (3) Explosion hazards of natural gas-air mixtures at high pressures used in secondary recovery of mineral oils. Flammability limits of natural gas-air mixtures have been measured over a wide range of pressures.

D. L. Nicol

Murray, R. C. and Hall, A. R. FLAME SPEEDS IN HYDRAZINE VAPOUR AND IN MIXTURES OF HYDRAZINE AND AMMONIA WITH OXYGEN. *Trans. Faraday Soc.*, (British) 47, 743-751 (1951) July.

Measurements of the flame speed by the flame cone method have been made for the vapor of 60.9 to 97.2% aqueous hydrazine at 150° C. The flame speeds in mixtures of this vapor with oxygen at 150° F. have been measured, as have the speeds of $NH_3 - O_2$ mixtures and mixtures of oxygen with a gas having the composition $NH_3 + \frac{1}{2}(N_2 + H_2)$. The purpose of the study is to record the measurement of the normal combustion velocity caused by the decomposition of hydrazine according to the overall process; $2 N_2 H_4 = 2NH_3 + N_2 + H_2$.

D. L. Nicol

INFLAMMABILITY RANGES OF PROPANE-AIR MIXTURES UNDER REDUCED PRESSURE. *Nature*, (British) **167**, 985 (1951) June 16.

Preliminary experiments with propane-air mixtures disclosed an inflammability diagram indicating an overlapping system of two different ranges, due to two different mechanisms of combustion. Two mixtures with high concentrations of nitrogen were used in an effort to separate the two ranges. The results are graphically presented.

W. E. Ball

Free Radicals

Miller, D. M. and Winkler, C. A. THE MEASUREMENT OF THE ABSOLUTE RATES OF REMOVAL OF LEAD AND

TELLURIUM MIRRORS BY A FREE RADICAL STREAM. *Can. J. Chem.*, 29, 537-543 (1951) July.

Two new methods were developed for measuring the absolute rate of removal of metallic mirrors by free radicals—a gravimetric procedure and a radioactive method. For lead and tellurium mirrors, it was shown that the same number of radicals react with each atom of both metals. It is suggested that lead dimethyl and tellurium dimethyl are the compounds formed.

C. H. Riesz

Gas Viscosity

Bromley, L. A. and Wilke, C. R. VISCOSITY BEHAVIOR OF GASES. *Ind. Eng. Chem.*, 43, 1641-1648 (1951) July.

A review is made of the methods for prediction of gas viscosity including effects of pressure, temperature and composition, and a presentation of these methods in convenient form for engineering use. Prediction of the effect of temperature at low pressure is based on the refined kinetic theory of Chapman and Cowling as developed by Hirschfelder, Bird and Spatz. Prediction of the effects of pressure and temperature on viscosity of gases at high pressures is based on the work of Ujehara and Watson.

D. L. Nicol

Keyes, F. G. A SUMMARY OF VISCOSITY AND HEAT-CONDUCTION DATA FOR He, A, H_2, N_2, CO, CO_2, H_2O, AND AIR. *Trans. Am. Soc. Mech. Engrs.*, 73, 589-596 (1951) July.

The available low-pressure viscosity data in the literature have been collected and formulated by means of an empirical equation containing three constants. At high temperatures, the equation approaches the well known Sutherland formula, which predicts the viscosity of a gas as a function of the temperature. The equation is compared graphically with the data of carbon dioxide and air. In the case of helium and argon, it was not found possible to represent the data over the entire range of the available measurements with a single set of constants. The viscosity of gas mixtures is discussed briefly, and the use of a theoretical formula deduced by Enskog is illustrated by application to binary mixtures, hydrogen-carbon dioxide and hydrogen-propane. The formulation of the available heat-conductivity data for the substances listed in the title has been carried out using an equation of the same form applied for viscosities. A table of formula constants for these substances is given.

N. L. Carr

Heavy Hydrogen

Fookson, A., Pomerantz, P., and Rich, E. H. PREPARATION AND PURIFICATION OF HYDROGEN DEUTERIDE. *J. Research, Nat. Bur. Standards*, 47, 31-34 (1951) July.

Preparation of HD of 99.8% purity by the reaction of D_2O with lithium hydride (LiAl H_4) is described.

S. Katz

High-Speed Photography

Conn, W. A. THE USE OF "EXPLODING WIRES" AS A LIGHT SOURCE OF VERY HIGH INTENSITY AND SHORT DURATION. *J. Opt. Soc. Amer.* 41, 445-449 (1951) July.

The flash of light observed in discharging large condensers through a very thin wire has been used as a light source for obtaining photographs and for making visual studies of rapidly moving objects. Copper wire was found most suitable for photographic exposures. Wires made of silver and Chromel gave good results in visual work. The energy emitted by an exploding copper wire was determined by a photographic photometric reduction in four regions of the sprectrum. The entire emission of a copper wire of 2.5-cm length amounts to $(6.5 \pm 0.3) \times 103$ watt/cm^2. Its emission in the visible region of the spectrum amounts to 9.6×10^8 candle power/cm^2. The values show the great amount of energy available for this type of work and point to future use. An example is given of the application of exploding wires in an industrial technique, showing the formation of soap granules in the spray drying process. Arrangements for multiple flashes and means of exploding materials not available as thin wires are discussed.

Author's Abstract

Surface Area Research

Jones, D. C. THE ADSORPTION ISOTHERM OF LANGMUIR AND OF BRUNAUER,

EMMETT, AND TELLER FOR MULTILAYERS WHERE n = 3. *J. Chem. Soc.* (London), 1464-1467 (1951) June.

An analysis of the adsorption isotherm of Langmuir and of Brunauer, Emmett, and Teller for multilayers, where the number of such layers is limited to 3, is made. The isotherms are shown to change from Type I through IV and V and then to Va as the values of c charnge from just greater than 2.16 to ca. 0.25. Three is thus the smallest value of n where all the known isotherm types for a limited number of multilayers can be encountered as c varies. At high values of c ($c > 1000$) the change of adsorption type from I to IV again occurs in this case. The $x/(V/V_m)$ against x curves are analyzed, especially in relation to approximations which hold at low values of x.

Author's Abstract

Joyner, L. G., Barrett, E. P. and Skold, R. THE DETERMINATION OF PORE VOLUME AND AREA DISTRIBUTIONS IN POROUS SUBSTANCES. II. COMPARISON BETWEEN NITROGEN ISOTHERM AND MERCURY POROSIMETER METHODS. *J. Am. Chem. Soc.*, 73, 3155-3158 (1951) July.

Two methods for obtaining the pore volume and area distribution with respect to pore radius were compared. In the indirect method, the desorption branch of the low temperature adsorption isotherm was determined; the direct method made use of a high pressure mercury porosimeter. Good agreement was obtained between distribution curves determined by the two methods. It was concluded that the most efficient equipment would consist of a porosimeter capable of exerting 500 to 1000 psi. for pores greater than 300 A radius, and adsorption apparatus for the smaller pore range.

W. E. Ball

Thermal Conductivity

Lenoir, J. M. and Comings, E. W. THERMAL CONDUCTIVITY OF GASES. MEASUREMENT AT HIGH PRESSURE. *Chem. Engr. Progress*, 47, 223-231 (1951) May.

An apparatus was constructed for measuring thermal conductivities of gases at high pressure. The design utilized dual annular layers of fluid with known and unknown thermal conductivities. The apparatus was calibrated such that an exact knowledge of the gas layer transfer through it was not required. Pressure-thermal conductivity isotherms for nitrogen, methane, argon, hydrogen, helium, ethylene, and carbon dioxide were determined from 1 to 200 atm., with temperatures ranging from 106° to 153° F. The precision of the measurements is believed to be 1½ per cent at low values of thermal conductivity and 3 per cent at higher values of thermal conducivities. The correlation by Comings and Nathan was found to give good agreement with the measured values except in the region near the critical state, where the correlation predicted low values.

N. L. Carr

Thermal Expansion

Burdick, M. D., Zweig, B., and Moreland, R. E. LINEAR THERMAL EXPANSION OF ARTIFICIAL GRAPHITES TO 1,370° C. *J. Research Nat. Bur. Standards*, 47, 35-40 (1951) July.

The linear expansions of a number of artificial graphites cut in three directions with respect to the axis of extrusion were measured between 20 and 1370° C. Reference is made to the use of chrome-alumel thermocouples in evacuated systems throughout the identical temperature range.

S. Katz

Thermodynamic Properties

Stuart, E. B., Yu, K. T., and Coull, J. THERMODYNAMIC PROPERTIES OF n-HEPTANE. *Chem. Eng. Progress*, 46, 311, 312 (1951) June.

The thermodynamic properties of n-heptane were calculated from P-V-T data, using the Beattie-Bridgeman equation at low densities (below one-half the central density) and graphical procedures at higher densities. The data are presented in a pressure-enthalpy diagram. The range covered is from 1 to 300 atmospheres, and 209 to 1800° F.

O. T. Bloomer

The following articles, the abstracts for which appear on the pages indicated, are also called to your attention:

Lecky, J. A. ADSORPTION OF WATER AND METHANOL ON COAL. p. 179

Wark, W. J. SPARK ANALYSIS OF SEMI-MICROSAMPLES. p. 192

9. ORGANIC CHEMISTRY

Petrochemicals

Egloff, G. BENZENE FROM PETROLEUM—HOW AND HOW MUCH. *Petroleum Refiner*, 30, 127-129 (1951) July.

Since coke oven operation, imports and coal hydrogenation do not offer much promise of expanding the supply of benzene, it is indicated that all of the increases will have to come from petroleum. Present petroleum processes include Hydroforming and the Shell two-stage process. The new catalytic reforming process and new catalysts will probably be increasingly utilized. Plant operation has shown that one of these processes, Platforming, is particularly well suited for the production of aromatics. With these processes it is expected that the oil industry can meet all demands for aromatics in the foreseeable future.

W. E. Ball

Resen, F. L. LION CHEMICAL PRODUCES 1,200 TONS DAILY OF PETROCHEMICALS FROM NATURAL GAS. *Oil Gas J.*, 50, 76-79 (1951) July 12.

The Lion Oil Company plant at El Dorado, Arkansas, produces 1,200 tons of products based on ammonia, approximately 10% of the nation's total private synthetic nitrogen production capacity. The operations are described briefly.

C. H. Riesz

CROPS CALL FOR AMMONIA. *Chem. Week*, 69, 9-16 (1951) July 28.

By the end of the year the ammonia production rate will be 610,000 tons per year more than last year. Most of the hydrogen for the increased tonnage will be derived from natural gas. The current ammonia production rate is 1,750,000 tons per year.

C. A. Berg

Polystyrene

Samaras, N. T., and Perry, E. COMMERCIAL PRODUCTION OF POLYSTYRENE. *J. Applied Chem.*, 1, 243-248 (1951) June.

The commercial polymerization of styrene is limited by the heat transfer necessary to remove the heat of reaction. The three polymerization methods—mass, suspension and emulsion—are similar in investment and operating costs and the final choice of process is a matter of specific circumstances.

C. H. Riesz

Solvent Extraction

Neuworth, M. B., Hofmann, V. and Kelly, T. E. FRACTIONAL EXTRACTION PROCESS FOR RECOVERY OF PURE TAR ACIDS. *Ind. Eng. Chem.*, 43, 1689-1700, (1951) July.

Caustic soda extraction of tar acids from tar distillates has the disadvantages of batch operation and consumption of reagents. A review of the literature showed that continuous solvent extraction methods had been explored using oxygenated solvents. These processes were not too satisfactory, owing to the production of impure tar acids or the necessity of recycling a substantial fraction of the tar acids to obtain a satisfactory recovery. A process has been developed for the recovery of tar acids from low temperature tar distillates based on fractional solvent extraction with aqueous methanol and hexane. Tar acids were recovered by this process in a yield and purity comparable with caustic soda-extracted acids. This extraction process has the advantage of requiring no recycle of feed. Low cost, easily recovered solvents are used. For tar distillates containing high concentrations of tar acids such as occur in low temperature tar, this solvent extraction process appears to be a significantly lower cost operation than caustic soda extraction.

Author's Abstract

Thiophenes

Appleby, W. G., and Sartor, A. F. (assigned to Shell Development Co.) PRODUCTION OF THIOPHENE COMPOUNDS FROM MONO-OLEFINS AND HYDROGEN SULFIDE WITH ALUMINA CATALYST. U.S. 2,558,507 (1951) June 26.

Thiophenes are produced by the interaction of gaseous mono-olefins with from two to six volumes of hydrogen sulfide at temperatures of

840-1200° F., contact times in the range 10-30 seconds and in the presence of an absorptive alumina or bauxite catalyst. Specific conditions for forming thiophene from butylene and from ethylene are presented. Dimethylthiophene is obtained by the interaction of propylene and hydrogen sulfide.

C. H. Riesz

Devaney L. W., Clarke, J. T., and Culnane, C. H. (assigned to The Texas Co.) THIOPHENE PREPARATION FROM HYDROCARBONS, ALCOHOLS, OR MONOHALO HYDRCARBONS AND SULFUR DIOXIDE. U.S. 2,558,716 (1951) July 3.

This invention relates to a process for the production of thiophene or thiophene derivatives by the catalytic reaction of sulfur dioxide or hydrogen sulfide with aliphatic hydrocarbons. Spent catalyst from the production of thiophene compounds by conversion of organic compounds with hydrogen sulfide was found to have increased activity for the production of thiophene by the sulfur dioxide reaction. Thus, a two-fold increase in the on-stream period of the catalyst was obtained. Chromia-alumina type catalysts used at about 1100° F. were effective for the production of 95% pure thiophene.

C. E. Hummel

Thiourea

Powers, R. E., and Mitchell, J. (assigned to Koppers Co.) PREPARATION OF THIOUREA. U. S. 2,560,596 (1951) July 17.

This patent claims a cyclic process for manufacture of thiourea by thermal isomerization of ammonium thiocyanate (see *Gas Abstracts* 7, 126, July 1951), in which yields are improved and decomposition avoided, by adding xylene as a moisture entrainer to the vacuum-evaporated aqueous solution of unconverted thiocyanate from the cold-water thiourea dissolving step. The xylene (or other non-solvent organic liquid) entrains the remaining water as vapor in a final vacuum distillation-dehydration step (during which incoming wet raw thiocyanate also may be dried), leaving a suspension of dry crystals which may be recycled to the converter, with or without removal of the xylene.

O. P. Brysch

The following articles, the abstracts for which appear on the pages indicated, are also called to your attention.

Medcalf, E. C. AROMATICS RECOVERY BY SOLVENT REFINING. p. 185

Sittig, M. THE PETROCHEMICAL ENGINEER LOOKS AT ROCKET FUEL. p. 176

10. CHEMICAL ENGINEERING

Air-Liquefaction

Collins, S. C. and McMahon, H. O. (assigned to Arthur D. Little, Inc.) CONTROL FOR OXYGEN PRODUCING APPARATUS. U.S. 2,553,550 (1951) May 22.

The patent pertains to oxygen production by air liquefication and rectification by heat exchange and expansion cooling in two 3-path exchange zones, the expansion valve being automatically controlled by the temperature of the liquefied constituents accumulating in the rectifier pot.

O. P. Brysch

Ogorzaly, H. J. (assigned to Standard Oil Development Co.) LIQUEFACTION OF AIR. U.S. 2,562,812 (1951) July 31.

The inventor proposes the use of an auxiliary cold-gas stream to provide refrigeration for air supplied to an air fractionating unit. This stream is used as the "unbalance" stream in the warmer stage of a 2-stage reversing exchanger to cause the re-evaporation of impurities, such as water, deposited from the incoming air. In a high-pressure hydrocarbon synthesis plant, such a stream may be dried synthesis tail-gas, cooled by expansion through an engine.

O. P. Brysch

Roberts, N. W. (assigned to The British Oxygen Company Ltd., London) FRACTIONAL SEPARATION OF AIR. U. S. 2,559,132 (1951) July 3.

This invention claims the separation of argon from air by treating an argon-oxygen product from a two-stage primary rectification zone in a secondary rectifying zone operating under higher pressure.

O. P. Brysch

Chilled Grinding

GRINDING WITH LIQUID N_2. *Chem. Eng.*, 58, 107 (1951) June.

The pulverization of a number of volatile, hygroscopic, viscous, and other substances of low melting point is made considerably easier, faster and consequently less expensive by chilling first with liquid nitrogen (—320° F.) in a direct contact heat exchanger, followed by a conventional grinder such as a hammer-mill pulverizer. The added cost of the nitrogen is between 2 to 12 cents per lb. material ground.

C. von Fredersdorff

Degasifying Liquids

Miller, B. D. (assigned to The Girdler Corp.) METHOD AND APPARATUS FOR REMOVING GASEOUS AND READILY VAPORIZABLE MATERIALS FROM LIQUIDS. U. S. 2,559,129 (1951) July 3.

This patent describes a continuous process for removing gaseous and readily vaporizable materials from liquids by contacting alternate film and spray forms of the liquid with a rapid flow of stripping gas. The contact zone of the apparatus is made up of two concentric shells with a helical baffle in the annular space providing the path for the stripping medium and the liquid to be treated.

C. E. Hummel

Drying of Steam

Crawford, C. D. HOW TO DRY PROCESS STEAM. *Petr. Processing*, 6, 734, 735 (1951) July.

A new type steam dryer is now in service at Ohio's Cleveland refinery. The unit consists of a drum 30" in diameter and 72" in height. The wet steam entry is located in the side 42" from the bottom. A Centrifix Corp. type FD purifier is located below the outlet in the top of the vessel. The design of the purifier is based on the cyclone principle of separation. The unit now handles 25,000 lb./hr. of wet steam and could handle 50,000 lb./hr. without a big increase in pressure drop.

W. G. Bair

Fluidization

Agarwal, O. P. and Storrow, J. A. HEAT TRANSFER IN FLUIDIZATION BEDS—PART II. *Chem. and Ind.* (British), 321-324 (1951), April 28.

Data from experiments carried out to determine the heat transfer from a heated wall to the air flowing through a fluidized bed are presented in graphical form. Various materials were used in the experiments, and the air rate was varied so as to furnish data for both static and fluidized beds. The flow relationships in the apparatus over a wide range of air rates remained very similar in all tests, with or without the packing material. The data indicate that the change from a fixed bed to a circulating bed has no effect on the heat transfer system. Calculations are based on the arithmetic mean at the terminal temperature differences.

J. J. Guyer

Morse, R. D. and Ballou, C. O. THE UNIFORMITY OF FLUIDIZATION—ITS MEASUREMENT AND USE. *Chem. Eng. Progress*, 47, 199-204 (1951) April.

A capacitor probe has been developed for testing uniformity of fluidization. The probe produces acceptable test results with materials which are good electrical insulation.

C. von Fredersdorff

Fog Removal

Ekman, F. O. and Johnstone, H. F. COLLECTION OF AEROSOLS IN A VENTURI SCRUBBER. *Ind. Eng. Chem.*, 43, 1358-1363, (1951) June.

The variables affecting the efficiency of the Venturi scrubber in removing aerosols were studied in a plexiglas laboratory size unit. By passing hot air into oil in an air-atomizing nozzle a fog consisting wholly of either 0.8 or 1.0 micron diameter droplets was produced. Three types of water introduction at the Venturi throat were used: (1) radially outward through four 0.073 in. holes located in a 0.125 in. 1.0 pipe; (2) radially inward through a pipe attached to the wall of the Venturi; (3) axially at the center of the throat. Correlation of efficiency vs. surface and of drops and throat velocity is made. At the lower efficiencies, the lowest pressure for the same pressure drop is obtained at low throat velocities and high liquid rates rather than vice versa. For collection efficiencies of 90% and higher, these differences became less and less.

C. L. Tsaros

Fahnoe, F., Lindroos, A. E., and Abelson, R. J. AEROSOL BUILD-UP TECHNIQUES. *Ind. Eng. Chem.*, 43, 1336-1346 (1951) June.

Commercial aerosol separators such as cyclones and scrubbers, which are essential components of wet removal systems, are known to be inefficient in removing particles whose diameter is below 2 microns. Build-up of such small particles to produce larger particles or agglomerates which can be efficiently removed, was investigated utilizing adiabatic steam and ethylene glycol vapor injection to produce condensation, water fog injection to promote impaction, sonic agglomeration, and combinations of these treatments. Utilizing an aerosol of 0.8-micron average particle diameter, a 95 to 99.8% effective build-up to 2 micron or larger particles was obtained by selected treatments; utilizing an aerosol of 0.3-micron average particle diameter, only 60% effective build-up was obtained. Tests of representative commercial-type separators, a cyclone and Peabody scrubber, on built-up aerosols showed that they remove substantially all the material built up to larger than 2 microns in diameter.

Author's Abstract

First, M. W., Moschella, R., Silverman, L. and Berly, E. PERFORMANCE OF WET CELL WASHERS FOR AEROSOLS. *Ind. Eng. Chem.*, 43, 1363-1370 (1951) June.

Studies of glass fiber filters were made to determine their range of usefulness as air- and gas-cleaning devices. Both dry and wetted filters were used. Below 1 micron particle diameter removal is largely by diffusion, between 1 and 2 microns removal is by streamline forces, and above 5 microns by inertial forces and impaction. Diameters of filter fibers ranged from 50 to 255 microns, decreasing fiber size causing increased removal efficiency. Below 100 microns fiber diameter, wet cells are considered impractical. Wet air-cleaning processes are desirable in mist removal or when the aerosol contains acid or alkaline gases. Pressure drop across the filter increases with fiber size, depth, and density, and with air rate.

C. L. Tsaros

Kiddoo, G. SONIC AGGLOMERATION: A NEW SOLUTION. *Chem. Eng.* 58, 154-156 (1951) May.

The primary function of a sonic agglomeration is to coalesce aerosol particles into large particles which can be removed in secondary collectors such as cyclones, impingement separators, or wet scrubbers. Particle vibration more closely approaches that of the gas, (1) the lower the frequency, (2) the smaller the particle, (3) the lower its density, and (4) the higher the gas viscosity. At any given sound intensity there is an optimum frequency for each particle size which gives the greatest relative motion for an aerosol containing a range of particle sizes. Lower frequencies, 1,000 to 4,000 cycles per second are more effective in agglomeration than ultrasonic frequencies. A minimum particle concentration is required to achieve a satisfactory number of particle collisions and subsequent agglomeration. Collection efficiency can be increased by introducing a fine spray of water into the agglomerating chamber or by recycling already-removed material. Optimum frequencies and particle concentrations can be determined only from actual operating data. Types of sound generators are described.

C. L. Tsaros

Vedder, W. O. FILTERS AID AT-SOURCE CONTROL OF DUSTS. *Chem. Eng.*, 58, 140-144 (1951) May.

Filtration is the method most widely applied for collecting dusts of 50 microns or lower. Objectives of dust removal are: improved working conditions, reduced soilage and spoilage, recirculation of clean air, saving of equipment wear, collection of valuable dusts. Factors in selecting a filter are: physical and chemical properties of dusts and conveying gas, amount of dust, temperature, moisture, filter location, intermittent or continous operation. Bag and screen type filters, cleaning methods, types of material, operating limits, and special-purpose filters are discussed.

C. L. Tsaros

REMOVAL OF SUBMICRON AEROSOL PARTICLES FROM MOVING GAS STREAM. *Ind. Eng. Chem.*, 43, 1532-1538 (1951) July.

A study of removal of aerosol particles from a moving gas stream by the use of steam exhauster-nozzles has been made. Under adiabatic conditions, condensation occurs near the orifice as result of the high jet-velocities. If a gas stream containing particles is mixed with the steam near the orifice, condensation on the particles would be expected. If wet steam were used, the process would be stabilized, and the droplets made to grow large enough in a condenser system so they could be more easily removed. Pilot plant tests on the removal of radioactive materials from the flue gases resulting from the incineration of radioactive wastes, using steam nozzles are described. Laboratory tests using dioctyl phthalate smoke particles 0.3 microns diameter were made to determine exactly where condensation occurred. This occurs very near the orifice, upstream to the point of entrance of the aspirated gases, so that particle removal is accomplished by an impaction-diffusion process. Adding a second orifice caused condensation on the particles admitted at the first orifice giving improved removal efficiency. However, certain characteristics of the first orifice were hampered. A second incinerator pilot plant was constructed which gave an efficiency of removal of 99.999999% as compared with 98.8% average efficiency of the first.

C. L. Tsaros

Fractionation

Hutt, J. L., and Huntington, R. L. PRESSURE DROP THROUGH BUBBLE CAPS. *Petroleum Refiner*, 30, 131-134 (1951) June.

The pressure drop necessary to cause a vapor to flow through the submerged slots of a bubble cap has been broken down into the various static and dynamic components. These are pressure drop due to: flow reversal in the bubble cap, liquid seal, slot opening, surface tension, and change of velocity. Equations are derived for each component.

C. L. Tsaros

Gamma-Ferric Oxide

Martin, J. (assigned to Columbian Carbon Co.) PRODUCTION OF GAMMA-FERRIC OXIDE HYDRATE AND GAMMA-FERRIC OXIDE. U. S. 2,560,970; 2,560,971 (1951) July 17.

These patents claim the production of the gamma form of ferric oxide and ferric oxide hydrate by precipitation from ferrous sulfate solution at 150-200° F. by alkaline or alkaline-earth metal hydroxides, then rapidly cooling, in the first case by diluting with ferrous sulfate solution, and in the second case with ferrous chloride solution, and oxidizing by aeration.

O. P. Brysch

Gas Mass Transfer

Hobson, M. and Thodos, G. MASS TRANSFER LAMINAR FLOW OF GASES THROUGH GRANULAR BEDS. *Chem. Eng. Progress*, 47, 370-375 (1951) July.

A correlation between the mass transfer coefficient factor "j" and the modified Reynold's number for a number of binary mixtures in gaseous phase has been obtained for flow through granular beds. A transition zone was obtained at the modified Reynold's number of 50 which corresponded to the Reynold's number of 2100 for fluid flow through a circular conduit. Below this region a linear correlation also was obtained for the granular beds.

S. Mori

Ore Reduction

Ogorzaly, H. J., and Martin, H. Z. (assigned to Standard Oil Development Co.) U. S. 2,562,-813 (1951) July 31.

A continuous process of smelting ores of fine particle-size without the use of coke is proposed, in which the ore is fluidized and injected cyclonically with preheated air or oxygen into a refractory vessel. Preheated fuel gas, injected separately, yields highly-reducing gases by partial combustion, which reduce the suspended ore to a ferrous state and melt it. The molten droplets, collected by gravity or baffling chambers into a pool at the bottom of the vessel, are reduced to metal by separate injection of proportioned pre-heated fuel gas and air.

O. P. Brysch

Packed Column Design

Hands, C. H. G., and Whitt, F. R. DESIGN OF PACKED DISTILLATION COLUMNS. IV. AN EMPIRICAL METHOD FOR THE ESTI-

MATION OF COLUMN HEIGHT USING THE H. E. T. P. CONCEPT. *J. Appl. Chem.* (British) **1**, 135-140 (1951) March.

Although the H. T. U. basis is sounder theoretically as a basis for column performance, the fact that data on specific systems and packing may not apply accurately to other systems and packings leads the authors to consider that a correlation based on the H. E. T. P. concept may be just as applicable for design purposes. A number of plots of H. E. T. P. vs. vapor velocity for various packings are given. From these a general linear plot for Rashig rings could be derived of log H. E. T. P. vs. log dimensionless ratio of reflux liquid mass-velocity divided by its viscosity times Rashig-ring diameter.

C. L. Tsaros

Pressure System Design

Buxton, W. J. and Burrows, W. R. FORMULA FOR PIPE THICKNESS. *Trans. Soc. Mech. Engrs.*, **73**, 575-587 (1951) July.

Because of its agreement with experimental stress measurements the so-called Lamé formula is advanced as the most suitable formula for the design of pipe under stress conditions within the elastic range. In the creep range, however, the Bailey-Nadai formula, based on an arbitrary shear stress-strain relationship is recommended. The latter formula is simplified to

$$\frac{P}{S} = \frac{1-(1-\frac{2}{D/T})^{2/n}}{2/n}$$

where P/S is the pressure/stress modulus, D/T is the diameter to thickness ratio and n is an empirical exponent. In the selection of these formulas, an examination was also made of the common, average (or membrane), Barlow, Clavarino and other formula and their significance is discussed.

C. von Fredersdorff

Jaep, W. F. A DESIGN PROCEDURE FOR INTEGRAL FLANGES WITH TAPERED HUBS. *Trans. Am. Soc. Mech. Engrs.*, **73**, 569-574 (1951) July.

A simplified procedure for applying the ASME flange stress formula for the design of tapered or straight hub integral flanges involves predetermination of the hub shape and the use of auxiliary graphs to facilitate the trial calculation for thickness.

C. von Fredersdorff

Olds, R. H. and Sage, B. H. TRANSIENT FLOW IN GAS TRANSMISSION LINES. *J. Petroleum Technol.*, **3**, 217-222 (1951) July.

An iterate graphical solution, to predict the pressure distribution in long pipe lines carrying gas under transient conditions is developed. The following assumptions are made. 1. Inertia effects are small. 2. Forces associated with acceleration of flow are neglected. 3. Simplified equation of state is used. 4. Operation is assumed isothermal. 5. Viscosity of gas is assumed constant with pressure. Two examples are solved and the method for solution is outlined. Example A considers the problem of the pressures resulting when the flow at the entrance of the pipe line is interrupted, and Example B predicts the cyclic pressure distribution to be anticipated in a gas transmission line with a constant input and a cyclic demand rate. This procedure may be expected to yield satisfactory results for wide variations in flow conditions, provided situations involving shock waves and supersonic flow do not arise.

D. C. Gami

Wesstrom, D. B. and Bergh, S. E. EFFECT OF INTERNAL PRESSURE ON STRESSES AND STRAINS IN BOLTED-FLANGED CONNECTIONS. *Trans. Am. Soc. Mech. Engrs.*, **73**, 553-568 (1951) July.

It is shown that elastic deformations and therefore the forces and moments in a bolted flanged connection vary with conditions of internal pressure and that the actual stresses existing in a bolted joint will vary in some cases considerably from these predicted by the equations in the ASME Unfired Pressure Vessel Code. For certain critical ranges of joint diameter, pressure and stress (particularly in large flanges) it is advisable to analyze the design for the actual stresses existing in assembling the joint, at test pressure, and at operating conditions. From a definition of the elastic deformation existing in a flanged joint and using the basic flange dimensions, relationships between the initial forces and moments at bolting up conditions and those at test pressure are derived. The results are summarized in the

form of a design procedure. Equations are also derived for the deformation and stresses in a flat cover-plate such as a bolted blind flange.

C. von Fredersdorff

Reactor Performance

Caddell, J. R. and Hurt, D. M. PRINCIPLES OF REACTOR DESIGN. HOMOGENEOUS REACTIONS. *Chem. Eng. Progress*, 47, 333-338 (1951) July.

A dimensionless number called the number of reaction units is introduced as a measure of reactor performance. From laboratory kinetic data, this number may be calculated, and by a graphical method a reactor of a given specification may be designed. Correlations on fractions of conversion and the number of reaction units are available for zero, first, and second order reactions.

S. Mori

Refractory Drying

Roberts, A. L. DRYING OF REFRACTORY MATERIAL. *J. Inst. Fuel* (British), 24, 126-128 (1951) May.

Drying is one of the most troublesome operations in the production of refractories due to shrinkage which accompanies removal of moisture during the constant-rate period and to the differential shrinkage stresses arising from moisture-content gradients set up between surface and interior. Once the whole of the clay mass has passed into the constant-rate period the danger of cracking is over. The moisture-content gradient is greatest at the drying surface and decreases progressively toward the center. The gradient is steepest at the end of the constant-rate period. It is generally felt that drying stresses would be minimized if the ware was heated to a temperature reasonably suitable throughout the mass and in an atmosphere of high humidity to minimize evaporation. These conditions are approached in the modern humidity dryer. Infra-red drying appears to be limited to thin objects.

C. L. Tsaros

Spray Scrubbing Research

Alexander, L. G. and Coldren, C. L. DROPLET TRANSFER FROM SUSPENDING AIR TO DUCT WALLS. *Ind. Eng. Chem.*, 43, 1325-1331 (1951) June.

Experiments were performed to elucidate the mechanism and measure the rates of deposition of small water droplets suspended in a turbulent air stream. An air-atomizing nozzle was used to inject the spray into a 1.86 in. I. D. steel tube of various lengths. The nozzle used was similar to that of Nukiyama and Tanasawa, and the mean diameter of the droplets produced was calculated from their formula to be about 27 microns. Water and atomizing air rates were held constant, and main air-stream velocities were varied from 80 to 295 ft. per sec. Mass velocity profiles were made by means of a spray collection rake at each of eight distances from the nozzle in the range 7.625 to 67.625 inches from the nozzle. Two distinct zones were observed, one close to the nozzle, within 25 inches, and one further away from the nozzle at 30 to 70 in. These zones were observed in plots of average mass velocity of suspended droplets vs. distance from the nozzle at constant air velocity. For zone 1, a tentative eddy diffusivity of water droplets was determined, and for zone II a film-type coefficient of mass transfer, varying as the 1.17 power of average air velocity, was determined.

C. L. Tsaros

Lane, W. R. SHATTER OF DROPS IN STREAMS OF AIR. *Ind. Eng. Chem.*, 43, 1312-1317 (1951) June.

The breakup of drops in steady air streams and transient (fast) air blasts is discussed and equations relating the variables are presented. In a steady stream of air the drop forms a "bag" which bursts into fragments when relative velocity of air and drop reach a certain critical value depending on the drop size. In transient air blasts where the relative velocity greatly exceeds the critical velocity in a steady air stream, the drops do not bag, but deform in the opposite direction, presenting a convex surface to the flow of air. The shatter velocity for a transient air-blast is shown to be 0.71 of that for a steady stream by considering the drop as a vibrating system. Experiments showed this ratio to be closely approached for drops of diameter, 2, 1, and 0.5 mm., but is exceeded for larger drops.

C. L. Tsaros

Mugele, R. A. and Evans, H. D. DROPLET SIZE DISTRIBUTION IN SPRAYS. *Ind. Eng. Chem.*, 43, 1317-1324 (1951) June.

A discussion of the fundamentals of spray and drop size distribution and the types of mean

diameters that are used to define sprays is given. Rosin-Rammler, Nukiyama-Tanasawa, and log-probability equations are discussed and the comparative point of these equations to a set of data is made. A modified probability equation, the upper limit equation, is proposed. Study of the deviations of the above distribution equations from observed data indicate that the best are, in order, the upper limit, Rosin-Rammler, log-probability and Nukiyama-Tanasawa.

C. L. Tsaros

Pigford, R. L., and Pyle, C. PERFORMANCE CHARACTERISTICS OF SPRAY-TYPE ABSORPTION EQUIPMENT. *Ind. Eng. Chem.*, 43, 1649-1662 (1951) July.

This is the most complete study of sprays yet reported. Measurements have been made of spray pattern distribution and drop-size distribution. Both solid- and hollow-cone spray producing nozzles have been compared, orifice diameters ranging from 0.078 to 0.281 inches. In this range, at 50 psi. nozzle pressure, mass-median diameter was found to be approximately proportional to orifice diameter. Most of the experimental runs were made using solid cone nozzles with orifice diameters in the range 0.078 to 0.125 inches. Usually one nozzle was used, mounted in the center at the top of a 31.5 in. tower with a 52-in. spray height. Runs were made for dehumidification and heat transfer, oxygen desorption, and ammonia absorption. Results were calculated as the number of transfer units and were presented for each of the above three processes as curves of number of transfer units vs. gas or liquid mass velocity at constant liquid or gas mass velocity respectively. It is concluded that spray towers are advantageous where low pressure drop and high gas velocities are desired, and where there may be a tendency with a given system toward clogging of a packed tower. Effectiveness of a spray tower per unit volume becomes less as the distance from the nozzle increases. The number of transfer-units is approximately proportional to the liquid rate. No performance improvement resulted when more small nozzles spaced more closely together are used to replace fewer large nozzles.

C. L. Tsaros

Storage Tanks

Boberg, I. E. HOW FIRM A FOUNDATION FOR YOUR OIL-STORAGE TANKS. *Oil Gas J.*, 50, 106, 107 (1951) June 7.

With the advent of larger and taller storage tanks, the proper design of foundations to avoid settling and bottom corrosion has become increasingly important. The usual provisions required for an adequate foundation are a firm well-rolled subgrade, the bearing ability of which must be tested when in doubt, a top layer of 4 in. thick packed crushed rock or sand, and a 5 ft. wide strip of bern or other suitable weatherproofing surrounding the tank. An excellent base for the tank may also be obtained by a 1½ in. layer of asphalt road paving mix on top of the subgrade. All contact with organic soil should be avoided and it is sometimes necessary to mix oil with the sand cushion used as a corrosion preventative. For larger tanks, it is customary to provide a ring-wall foundation on which the periphery of the tank rests. The ring-wall confines the soil and prevents lateral displacement under load conditions. An adequate ring-wall is designed so that the soil pressure at the level of the bottom of the wall is the same under the concrete as under the confined soil. Formulas are given for (1) thickness of the wall, and (2) steel reinforcing area required in the ring wall.

C. von Fredersdorff

Kerr, P. RESTRAINTS ON THE EXPANSION OF VERTICAL TANKS UNDER LIQUID HEAD. *J. Inst. Petroleum* (British) 37, 209-223 (1951) April.

The author presents formulae for the correction of calculated tank volumes, based on the restraining effect on expansion by the tank bottom, roof, straps and weld seams.

C. von Fredersdorff

Tower Cleaning

Bowes, V. E. CHEMICAL CIRCULATION CLEANING OF TOWERS. *Petroleum Engr.*, 23, C, 5-8, 10 (1951) May.

The chemical circulation method of cleaning is widely used and finding increasing favor. This method is not only faster and more economical, but in many cases reaches areas hidden to cleaning tools. Manufacturers of chemical

agents have devised and made available simplified and highly workable methods of doing this work. The success of these methods depends on one very important factor: analyzing the characteristics of these fouling substances and prescribing the right chemical to break the binder that holds the soil to the tower surfaces. Equipment set up for the cleaning process is described.

C. L. Tsaros

Vaporization Mechanism

Plewes, A. C. and Klassen, J. A STUDY OF MASS TRANSFER RATES FROM THE SOLID TO THE GAS PHASE. *Can. J. Technology*, 29, 322-331 (1951) July.

Five pure solids — cyclohexane, phenol, camphor, benzene and p-dichlorobenzene — have been vaporized in turbulent air streams. The results were correlated by the Sherwood-Gilliland relationship for the vaporization of liquids from moving films into turbulent air streams. The work indicates that the mechanism for mass transfer in gas-solid and gas-liquid systems are analogous.

C. H. Riesz

11. PROCESS EQUIPMENT AND INSTRUMENTATION

Combustible Gas Detector

Taylor, F., Jr. THERMOCOUPLE-TYPE COMBUSTIBLE GAS ANALYZER EXPANDS FIELD OF APPLICATION. *Petroleum Refiner*, 30, 124-126 (1951) July.

This combustible gas analyzer utilizes the temperature increase of a heated platinum filament when exposed to a combustible gas as compared to a similar heated filament and thermocouple sealed in air to form a differential emf. which is applied to an electronic potentiometer. The potentiometer, properly calibrated, indicates the proportion of combustible gas present in terms of the per cent of its lower explosive limit. Single-point and four, six or eight-point recording tube-units have been developed.

C. E. Hummel

Orifice Meters

Cunningham, R. G. ORIFICE METERS WITH SUPERCRITICAL COMPRESSIBLE FLOW. *Trans. Am. Soc. Mech. Engrs.*, 73, 625-638 (1951) July.

Contrary to the case of the convergent nozzle, the square-edged orifice does not exhibit a maximum flow ratio. Experiments show that the flow rate, for constant upsteam conditions, continues to increase at all pressure ratios between the critical and zero. The range is defined as the "supercritical" range. The expansion factor of the orifice meter equation was found to be related linearly with pressure ratio at low pressure ratios, and a change of flow regime was found to occur at a pressure ratio of 0.63. An equation is suggested and the use of the square-edge orifice meter is encouraged for supercritical flow.

J. D. Parent

Grace, H. P. and Lapple, C. E. DISCHARGE COEFFICIENTS OF SMALL DIAMETER ORIFICES AND FLOW NOZZLES. *Trans. Soc., Mech. Engrs.*, 73, 639-647 (1951) July.

Discharge measurements were made in a standard 1-in. pipe for thick-plate and knife-edge orifices of $\frac{1}{32}$-in. to $\frac{3}{4}$-in. diam. and for critical flow nozzles of $\frac{1}{32}$-in. to $\frac{1}{4}$-in. diam., and the results expressed in terms of a discharge coefficient C or C_n as given in the theoretical equations,

(a) non-critical flow

$$W = CA\sqrt{2\, g_c\, \rho ave.\, \Delta\, p/(1-\beta^4)}$$

(b) critical flow

$$W = C_n A p_o \sqrt{(g_c\, k\, M/RT_o)\,[2/_{k+1}]^{k+1/_{k-1}}}$$

where W is the mass flow rate, A the orifice area, p_o the absolute upstream pressure, g_c the gravitational constant, k the ratio of specific heats, Δ p the orifice differential, M the molecular weight, R the gas constant, T_o the absolute upstream temperature, ρ ave. the average density of fluid at the orifice plate and β the ratio of orifice to pipe diameter. Reproducibility was good ($\pm$ 0.5%) for properly constructed knife-edge orifices, but was very poor for small orifices of $\frac{1}{4}$ to 1- hole diam. thickness. Thick-plate orifices (1 - hole diam. thickness) were found to be as good as or better than nozzles as regards constancy of discharge coefficients under critical flow conditions.

C. von Fredersdorff

Hardway, E. V., Jr. A METHOD FOR CORRECTING ORIFICE-METER MEASUREMENTS FOR FLOW PULSATIONS. *Instruments*, 24, 763-765, 774, 775 (1951) July.

An approximate method for calculating flow meter errors caused by pulsations in the line is presented. The resultant error expression, which uses only the root mean square and average values of the differential pressure, is tested and found to give an accuracy of one per cent flow up to pulsation errors of about 7 per cent. Tentative instrument action for obtaining the root mean square value and for using the method is shown.

D. L. Nicol

Oxygen Recorder

Cipriano, L. D., and Riggs, O. W. OXYGEN MEASUREMENT AS A GUIDE TO COMBUSTION EFFICIENCY. *Oil Gas J.*, 50, 90-92, 100 (1951) July 12.

The design and application of a continuous oxygen recorder-indicator utilizing the paramagnetic properties of oxygen are discussed.

H. R. Linden

Radiation Pyrometer

Tilton, D. G. (assigned to Minneapolis-Honeywell Regulator Co.) RADIATION PYROMETER. U. S. 2,561,077 (1951) July 17.

A radiation pyrometer, sensitive between 0-200° F. using wave lengths between 10 to 20 microns is described. Essentially, it consists of a sodium chloride lens, with a thin layer of magnesium fluoride protection, which focuses the radiant beam into a thermopile or radiation receiving element. The whole system is enclosed in a sealed housing.

S. Mori

Sealed Gas Pump

Puddington, I. E. ELECTROMAGNETIC MERCURY PUMPS FOR CIRCULATING GASES. *Can. J. Technology*, 29, 311-316 (1951) July.

Two types of mercury positive-displacement pumps useful in circulation of gases inside a glass-sealed system are described. By passing an electric current through mercury at right angles to an applied magnetic field, a positive flow may be obtained. In this first type, mercury is made to flow back and forth between two large reservoirs by changing the direction of electric current, while in the second type mercury is made to flow in slugs continuously through a fine capillary in one direction.

S. Mori

The following articles, the abstracts for which appear on the pages indicated, are also called to your attention:

Cooper, J. CONTINUOUS DETERMINATION OF SMALL CONCENTRATIONS OF H_2S IN TOWN AND OTHER GASES. p. 190

Marsh, J. S. SIGNIFICANCE OF AIR TEMPERATURE IN OPEN HEARTH OPERATION. p. 189

Percy, J. W. COMPARISON OF METHODS FOR MEASURING TEMPERATURE OF MOLTEN METALS. p. 189

Veiock, L. H. A THERMOCOUPLE SYSTEM FOR MOLTEN-METAL TEMPERATURE MEASUREMENT. p. 190

12. MATERIALS OF CONSTRUCTION

Cast Iron Pipe

Daniel, K. R. CENTRIFUGAL CASTING OF PIPE IN SAND-LINED MOLDS. *Mech. Eng.*, 73, 644-648 (1951) August.

A brief history of the use of cast iron pipe is given. The process whereby Monocast, the centrifugally cast iron pipe, is made is described in some detail.

B. E. Hunt

Cathodic Protection

Holler, H. D. THE ROLE OF CURRENT DISTRIBUTION IN CATHODIC PROTECTION. *J. Research Nat. Bur. Standards*, 47, 1-6 (1951) July.

A laboratory method of measuring the current distribution during cathodic protection is described. The possible application of this method to field tests is suggested. From the laboratory tests the interpretation of the field data is indicated.

B. E. Hunt

Peabody, A. W. IMPRESSED CURRENT GROUND BEDS FOR CATHODIC PROTECTION. *Gas*, 27, 37-41 (1951) July.

The developments and present practises pertaining to ground-bed materials and construction materials, are discussed. The effects of soil conditions, anode configuration, and other factors on the performance and design of ground-bed installations are discussed.

B. E. Hunt

Schreiner, W. J. ABOVE-GROUND CATHODIC PROTECTION. *Am. Gas Assoc. Monthly*, 33, 31, 32 (1951) July-August.

The application of cathodic protection for the protection of a large tank bottom is described. Galvanic anodes were used in this installation.

B. E. Hunt

Ceramic-Metal Bonds

Bondley, R. J. LOW MELTING TEMPERATURE SOLDERS IN METAL-CERAMIC SEALS. *Ceramic Age*, 58, 15-18 (1951) July.

A method of bonding a strong vacuum-tight sealed joint between ceramic and metal is described. The feasibility of joining various metals and ceramics is determined by their physical properties as shown by means of charts in this article. Two methods of bonding are: (1) heating metal powder-glass mixture on the ceramic in a reducing atmosphere or (2) applying and heating titanium hydride on the ceramic in vacuum and soldering the metal to it. The latter gave a more satisfactory seal.

S. Mori

Coatings

Markle, M. G. HOW COAL TAR TAPE SOLVED DISTRIBUTION PROBLEMS. *Gas Age*, 3, 13, 14, 50 (1951) August 2.

The description of a cotton tape impregnated with coal tar for use in wrapping miscellaneous fittings and exposed sections of pipe is given. This tape requires the application of a small amount of heat to form a tight seal.

B. E. Hunt

Rogers, W. F., Davis, B. H., Sheppard, L., Sharpe, L. G., Allen, E. R., Bond, D. and Miller, P. T. A PROPOSED STANDARD METHOD FOR MEASURING THE ELECTRICAL RESISTANCE OF PIPE LINE COATINGS. *Corrosion*, 7, 245 (1951) July.

The method outlined consists of impressing a known potential across the pipe line coating and measuring the resulting current flow.

B. E. Hunt

Corrosion

Doig, K. and Wachter, A. BACTERIAL CASING CORROSION IN THE VENTURA FIELD. *Corrosion*, 7, 212-224 (1951) July.

The increasing number of failures in the well casings at the Ventura Avenue field, prompted a careful investigation. Stray currents, mechanical factors, corrosive strata, defective steel, and migration of salt water were discounted; however from the findings on a recovered casing, the corroded region indicated that the cause was due to anaerobic sulfate-reducing bacteria. Preventative measures can be taken on new wells by using a higher *p*H (9.0) mud, but no solution has been obtained for existing wells.

S. Mori

Fontana, M. G. CORROSION . . . THE FIRST OF A SERIES OF COLUMNS SUMMARIZING CORROSION DATA IN CHART FORM PRESENTS TEMPERATURES AND CONCENTRATIONS FOR CORROSION OF STEEL BY SULFURIC ACID. *Ind. Eng. Chem.* 43A, 65-68 (1951) August.

A chart is presented and discussed concerning the corrosion of carbon steel by sulfuric acid over wide ranges of strength and temperature.

B. E. Hunt

Murray, C. A. and Furth, M. A. CORROSION-PREVENTION IN A TCC GAS PLANT. *Petroleum Engr.*, 23C, 3, 5-12 (1951) Reference Ann.

The corrosion-control measures necessary for the successful operation of the gas plant of a TCC unit are discussed. Refinery examination coupled with laboratory data indicated that the principal corrodents present were hydrogen sulfide, ammonia and unidentified organic acids in water solutions. The principal preventive measure taken was the elimination of the excess water. Subsequent examinations showed the corrosion to be greatly decreased after the initiation of this program.

B. E. Hunt

Parker, M. E., CORROSION AND ITS CONTROL — INSULATED JOINTS IN CATHODIC PROTECTION. Part 18. *Oil Gas J.*, 50, 81 (1951) July 5.

Insulating joints serve to isolate sections and permit sectionalization of the pipe line. Unintentional short circuits are discussed.

B. E. Hunt

Parker, M. E. CORROSION AND ITS CONTROL-RECTIFIERS FOR CATHODIC PROTECTION. Part 19. *Oil Gas J.*, 50, 110 (1951) July 12.

Cathodic protection rectifiers are classified according to the method of rectification, rectifier circuits, and methods of housing and cooling.

B. E. Hunt

Parker, M. E. CORROSION AND ITS CONTROL—GROUND BEDS. Part 20. *Oil Gas J.* 50, 100 (1951) July 19.

The three important factors of ground bed design—resistance, permanency and cost are discussed. Some construction details are mentioned.

B. E. Hunt

Parker, M. E. CORROSION AND ITS CONTROL. GRAPHITE ROD AND GROUND BEDS. Part 21. *Oil Gas J.*, 50, 344 (1951) July 26.

The selection of the proper number of rods, at the proper spacing to combine to form a bed whose resistance is such that the total annual cost shall be a minimum is discussed. An example calculation is included.

B. E. Hunt

Parker, M. E. CORROSION AND ITS CONTROL—BIMETALLIC CORROSION. Part 22. *Oil Gas J.* 50, 81 (1951) August 2.

The electrochemical series is considered as the basis for the explanation of galvanic corrosion. This series, as usually given, is based upon measurements made under certain specified conditions and thus are not directly applicable to actual conditions. B. E. Hunt

Parker, M. E. CORROSION AND ITS CONTROL—CORROSION INSTRUMENTS. Part 23. *Oil Gas J.*, 50, 108 (1951) August 9.

The type of circuits, the applications, and the advantages and limitations of potentiometer-type instruments are discussed.

B. E. Hunt

Metallization

Young, J. E., Jr. METALLIZING—TO PROLONG LIFE OF REFINERY. *Petroleum Refiner*, 30, 118-120 (1951) July.

The process of metallizing is being widely used to prolong the life of refinery equipment. Two factors which must be considered for successful usage are: (1) the deposited metal is not welded but is held to the base metal by a mechanical bond, and (2) the metal is "cast" and must be handled as a casting. Detailed procedures for cylindrical and flat surfaces are given.

B. E. Hunt

Refractories

Firkin, T. M. REFRACTORY MATERIALS IN GAS MAKING PLANT. *Ceramics*, 28, 215-222 (1951) June.

The properties of refractories for gas manufacturing, particularly in vertical and horizontal retorts, are discussed. Silica refractories are characterized by high melting, high strength, good conductivity, and rigidity. The peculiar expanding properties and thermal spalling of silica must be taken into consideration in the use of this material. Siliceous firebrick has a lower refractoriness under load than silica, but expands only slightly, and is resistant to spalling. Small, regular shapes, and the provision of small-radius fillets, will minimize stresses.

W. E. Ball

Weber, G. CRACKED-CRACKER STUDY. *Oil Gas J.*, 50, 57 (1951) July 19.

The research, to date, on the graphitization of carbon steels is reported. A subcommittee of the API has outlined a program covering the general considerations and the procedure to be followed.

B. E. Hunt

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LP Gas

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